Standard Size, 9 x 12. DECEMBER 3, 1896. Price, Six Cents.

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE AMERICAN MACHINIST PUB. CO.,

VOL. 19. 256 BROADWAY, NEW YORK. No. 49.

CONTENTS.

	PAGE
"Planed" Bevel Gear Teeth. By George B. Grant	1119
The Construction of an Accurate Large Spur Gear	1120
Universal Monitor Lathe	1121
The Taylor Hydraulic Air Compressor	1122
The Printing Press in the Drafting Office. By W. H. Sargent	1123
The Best Air Compressor for Shop Service. By Frank Richards	1123
Engineers for the Navy	1124
Lathe Tail-Stocks—The Tail-Spindle Turret. By Tecumseh Swift	1125
Formulæ for Ball Bearings. By H. Rolfe	1126
Diagram of Proportions of Elliptical Arms	1127
The Mossberg End-Thrust Roller Bearing. By J. L. Lucas	1129
A Variable Speed Countershaft	1129
Electrical Machinery: The Jungfrau Mountain Electric Railway.... Making Armature Disks	1130
Letters from Practical Men: Abuses of the Patent Law. By Patentee. ....The Elasticity of Water. By Sidney A. Reeve....An Extra Drill Spindle. By J. Landsing.... "Established Engineering Practice." By Thermo....Limits of Error in Taps and Dies. By Sir C. Purcell Taylor....When the Air-Pump Bucket Valve Breaks. By A. W. Bollinckx....Municipal Taxation in Glasgow. By Geo. Harrison Law....Computing Angles. By A Reader.... High-Speed Drilling for Deep Holes. By Peter Lobben	1133-1135
Opportunities for American Capitalists and Manufacturers in Siam	1137
"La Grande Duchesse"	1137
The American Foundrymen's Association	1137
Use Steel Adapted to the Purpose	1138
Self-Propelled Vehicles in England.	1138
Second Annual Convention of the National Association of Manufacturers	1138
Questions and Answers	1138
Commercial Review	1140

Index to Articles Advertised, Pages 10 to 13.

Index to Advertisers, Page 9.

SOME NEW SPECIAL RATES

ADVERTISING RATES

OF THE

AMERICAN MACHINIST

PUBLISHED BY

American Machinist Publishing Co.,

256 BROADWAY, NEW YORK.

Display Advertisements can be inserted for one time or more at a uniform rate of $2.50 per inch per issue (single col. measurement),	**$2.50**
A discount, reducing this to $2.40 per inch per issue if paid by 15th of succeeding month, is allowed,	**$2.40**
Special price for space amounting to 250 inches or more, $2.25 per inch for each insertion, to be used weekly as desired,	**$2.25**
Special price for space amounting to 500 or more inches per year, $2.00 per inch for each insertion. Space to be used weekly as desired	**$2.00**
Special price for space amounting to 750 or more inches per year, $1.90 per inch for each insertion. Space to be used weekly as desired	**$1.90**
Special price for space amounting to 1000 or more inches per year, $1.80 per inch for each insertion. Space to be used weekly as desired	**$1.80**

WANTED COLUMN.

Situations, Help and Miscellaneous Wants, 30c. per line, Nonpareil.

BUSINESS SPECIALS.

Transient (Special Position), 40c. per line, Nonp.

No discount from the above rates.

Advertising spaces may be either single, double or three column, with or without engravings, as desired. *Cut and Copy may be changed as often as desired.*

Columns, 2¼ inches wide.

YEARLY RATES FOR COVER AND SPECIAL POSITIONS.

Outside Front Cover, for each insertion, $100.00
Outside Back Cover Space, - per inch, 200.00
Opp. 1st Page of Reading Matter, " 150.00

Indexing without advertising, 25 cents per line each insertion.

THE "rate per inch per issue" has been a popular change from our old complicated card rate.

The flat rate is fair to all. Our special contract giving reduced rate for 500 inches used within a year just fills the bill for over forty concerns who have signed it.

But there are firms that do not feel that their business warrants such a large expenditure and yet they want to advertise liberally. We have made a special rate for 250 inch advertisers.

Several big firms have offered us 1000 inch contracts for a fair discount on the 500 inch price. We have made a special rate for 750 and 1000 inch advertisers.

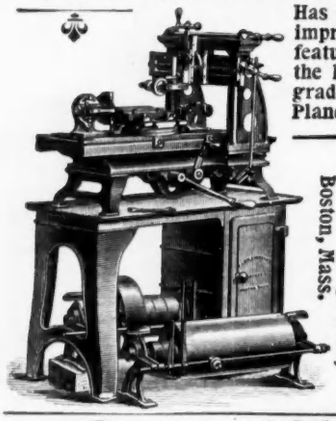
This is the American Machinist rate card from now on—no secrets, no figuring,—so much per inch per issue, with lower rate for specified number of inches to be used during one year.

Wholesale buyers always get lower prices. Here they are, take your choice.

Be a wholesale buyer of space—that makes a wholesale seller.

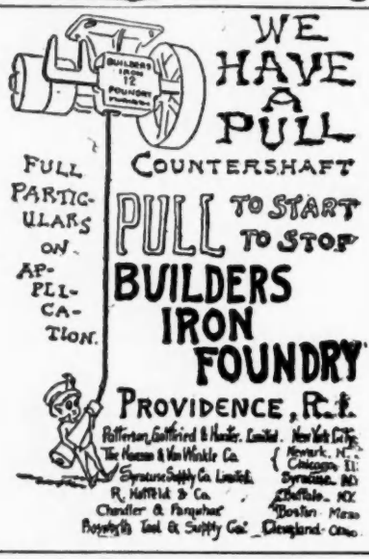
Power or Hand

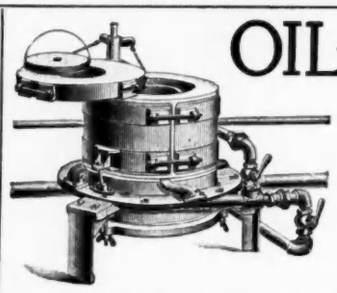
PLANER For Model Makers' Experimental Work. Capable of doing the Best and Finest Work.



Has all the improved features of the highest grade Planers.

Manufactured by A. J. WILKINSON & CO 184 Washington St., Boston, Mass.





OIL GAS PLANTS

GAS BLAST FURNACES AND HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

Catalogues on Application.

AMERICAN GAS FURNACE CO., 80 NASSAU STREET, NEW YORK.

English Agency, CHAS. CHURCHILL & CO., Ltd., London & Birmingham, Eng.

R. Mushet's

SPECIAL AND TITANIC STEELS.

THE STANDARD OF EXCELLENCE.

B. M. JONES & CO. BOSTON and NEW YORK.

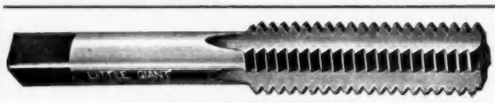
UNIVERSAL AND PLAIN GRINDING MACHINES

Eight Sizes. Our Machines are money savers, accurate workers and durable tools. The free use of water in Grinding saves 50 per cent in time of finishing.

To those interested, we are pleased to send full particulars.

LANDIS BROS., Manufacturers, WAYNESBORO, PA., U. S. A.

AGENTS { ENGLAND, C. W. BURTON, GRIFFITHS & CO., London and Birmingham. FRANCE, AD. JANSSENS, 16 Place de la Republique, Paris. GERMANY, SCHUCHARDT & SCHUTTE, 59 Spandauerstrasse, Berlin. AUSTRIA, " " " 17 Breitgasse, Vienna.



FINE TAPS

OF EVERY DESCRIPTION.

Manufactured by WELLS BROS. & CO., Greenfield, Mass., U. S. A.

WE DESIGN AND BUILD

MACHINERY AND TOOLS

Or Parts of Machinery of any kind.

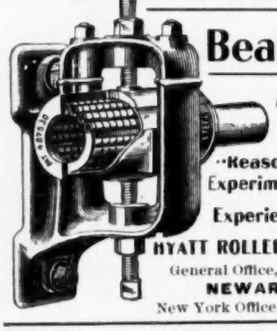
Models Built and Inventions Perfected.

for All Purposes.

Write for estimates to F. R. McMULLIN MFG. CO., General Office: Suite 513-514, 218 La Salle St. Chicago, Ill.

3 Years' Record.

Flexible Roller Bearings



ARE SUPERIOR.

A fact which "Reason Perceives, Experiment Verifies AND Experience Confirms"

HYATT ROLLER BEARING CO., General Office, 450 Market St., NEWARK, N. J. New York Office, 26 Cortlandt St.

We manufacture a complete line of

DRILLS

for light work, one or more SPINDLES, hand or automatic feed, of thorough workmanship and strictly up to date.

Prompt delivery on regular styles.

New Catalogue on application.

DWIGHT SLATE MACHINE CO..... HARTFORD, CONN.

Chas. Churchill & Co., Ltd., London and Birmingham. Schuchardt & Schutte, Berlin, Germany.

MOFFET PORTABLE DRILL.

UNSURPASSED AS A REAMER.

Will work in any position.

Weighs 48 lbs. and drills from ⅛ to 2¼ inches diameter.

RUNS WITH STEAM —OR— COMPRESSED AIR.

Send for Circular.

Manufactured by J. G. TIMOLAT, 465-467 W. Broadway, NEW YORK.

BRASS CASTINGS for all purposes. PHOSPHOR BRONZE for Machine Box Bearings, etc. Special Finished Brass Work to order.

NOLTE BRASS CO. 68 AND 70 EAST WASHINGTON STREET, SPRINGFIELD, O.

For All Shaft Sizes. **HUB THRUST BEARINGS.**

They Kill Friction, They Save Oil, They Cannot Heat.

They Will Run at Any Speed, They Will Carry Any Load, They Are Durable.

PATENTED. Write for Prices.

THE BALL BEARING CO. 10 Watson St., BOSTON, MASS.

DRILLS.

12" 16" 21" 24" 28" 32" 36" 40" & 44"

The most modern Drill Presses in the market. Hammered Steel Spindles, Phosphor Bronze Worm-Wheels, Steel Pinions, Etc., Etc.

Our Automatic Stop excels everything of the kind. Don't buy until you have investigated what we have to offer. Send for Catalogue.

Built by The Hamilton Mch. Tool Co. Zimmerman Ave., Hamilton, Ohio.

Metal Coiling Machines

For Sheet, Tubing, Rods, etc.,

The Torrington Mfg. Co. TORRINGTON, CONN.

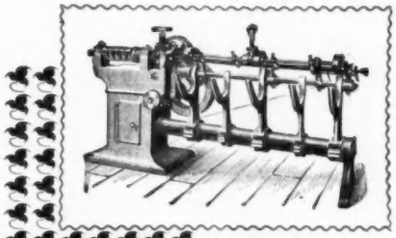
Index to Advertisers.

	PAGE
Abbott, Wheelock & Co	43
Acme Machinery Co	14
Adams, A. L	4
Adams Co., The	4
Adt & Son, John	9
Albro-Clem Elevator Co	6
Almond, T. R	10
American Gas Furnace Co	2
Ames Iron Works	46
Armstrong Bros. Tool Co	45
Armstrong Mfg. Co	8
Ashcroft Mfg. Co	48
Aurora Tool Works	41
Bacon, L. Seward	46
Backus Water Motor Co	46
Baird & Co., Henry Carey	45
Ball-Bearing Co., The	2
Barker & Co., William	3
Bardons & Oliver	13
Barnes Co., W. F. & John	8
Bates, Henry H	41
Baush & Harris Machine Tool Co	47
Becher, James A	45
Besly & Co., Chas. H	41
Bethlehem Foundry and Machine Co	10
Betts Machine Co	39
Bickford Drill and Tool Co	40 and 43
Bickford, H	48
Bilgram, Hugo	11
Blaisdell & Co., P	11
Bliss Co., E. W	12
Boston Gear Works	46
Box 62	4
Bradford Mill Co., The	11
Bremer Machine Co., Godfrey J	40
Brown & Sharpe Mfg. Co	48
Buchel Machine Works	40
Buffalo Forge Co	47
Builders Iron Foundry	2
Bullard Machine Tool Co	42
Burr & Son, John T	42
Carborundum Co., The	6
Cincinnati Milling Machine Co	42
Cleveland Machine Screw Co	6
Cleveland Twist Drill Co	43
Clough, R. M	10
Coburn Trolley Track Mfg. Co., The	45
Coffin & Leighton	43
Columbia University	40
Conover Mfg. Co	6
Crescent Steel Co	43
Crocker-Wheeler Electric Co	4
Cumberland Iron & Steel Shafting Co	4
Curtis & Curtis	37
Cushman Chuck Co	3
Daimler Motor Co	46
Dallett & Co., Thos. H	9
Davis & Egan Mach. Tool Co	45
Dawson & Goodwin	4
Deane Steam Pump Co	14
Detrick & Harvey Machine Co	47
Diamond Machine Co	41
Dietz, Schumacher & Boye	40
Dixon Crucible Co., Joseph	45
Dreses, Mueller & Co	13
Dwight Slate Machine Co	2
Dyer & Driscoll	39
Elliott Chemical Co	45
Erlandsen, J	10
Evans Friction Cone Co	6
Fay & Co., J. A	3
Fay & Scott	9
Ferracute Machine Co	10
Fifield Tool Co	48
Fitchburg Machine Works	43
Flather & Co	47
Forbes & Co., W. D	13
Fraser Machine Works	10
Frick Co., The	46
Garvin Machine Co., The	8
General Electric Co	44
Geometric Drill Co	3
Gooch, Chas. J	37
Goodyear, S. W	43
Gould & Eberhardt	8 and 14
Grant Gear Works	14
Gray Co., G. A	14
Hamilton Machine Tool Co	2
Hampden Corundum Wheel Co	3
Harrington & King Perforating Co	48
Harrington, Son & Co., E	41
Hartford Steam Boiler and Ins. Co	42
Hendey Machine Co	38
Hill, Clarke & Co	7
Hoggson & Pettis Mfg. Co	3
Horton & Son Co., E	3
Hurlbut-Rogers Machine Co	47
Hyatt Roller Bearing Co	2
International Correspondence Schools	6
Jenkins Bros	39
Johns Mfg. Co., H. W	47
Jones & Co., B. M	2
Jones & Lamson Machine Co	14 and 48
Kelly & Jones Co	41
Keuffel & Esser Co	45
Keystone Engine and Machine Works	46
Landis Bros	2
Le Blond, R. K	11
LeCount, Wm. G	3
Lodge & Shipley Machine Tool Co	5
Long & Allstatter Co	3
Maris Bros	47
McCabe, J. J	8
McFadden Co	12
McMullin Mfg. Co., F. R	2
Mergenthaler & Co., Ott	12
Merriam Co., G. & C	42
Mewer Tool Co	41
Mietz & Weiss	44
Miner & Peck Mfg. Co	47
Montgomery & Co	40
Morse Twist Drill & Machine Co	6
Mossberg & Granville Mfg. Co	40
National Machinery Co	4
Newark Machine Tool Co	41
New Doty Mfg. Co	47
New Haven Mfg. Co	8
New Process Raw Hide Co	10
Newton Machine Tool Works	13
Nicholson File Co	14
Niles Tool Works Co	14
Niles Tool Works Co., N. Y. Branch	8
Nolte Brass Co	2
Norton & Jones Machine Tool Works	6
Norton Emery Wheel Co	39
Oneida Mfg. Chuck Co	3
Otto Gas Engine Works	46
Pancoast Ventilator Co	3
Penberthy Injector Co	11
Philadelphia Book Co	37
Phosphor Bronze Smelting Co., Ltd	13
Pierce Engine Co	46
Pope Tube Co	5
Pratt & Whitney Co	39
Pratt Chuck Co	3
Prentiss Tool & Supply Co	8
Prouty Co., The	46
Pryibil, P	37 and 44
Q. and C. Co	47
Rand Drill Co	46
Reece, Edw. J	43
Reed Co., F. E	41
Reliance Steel Castings Co., Ltd	46
Rogers Boat Gauge & Drill Works, John M	3
Roots, P. H. & F. M	47
Rue Mfg. Co	45
Saunders' Sons, D	6
Sawyer Tool Co	41
Sebastian Lathe Co	39
Sellers & Co., Inc., Wm	14
Seneca Falls Mfg. Co	39
Shriver & Co., T	43
Sibley & Ware	4
Skinner Chuck Co	3
Slocomb & Co., J. T	11
Snyder, J. E	41
Springfield Gas Engine Co., The	46
Standard Tool Co	4
Stark, John	43
Sterling Emery Wheel Mfg. Co	43
Stiles & Fladd Press Co., The	12
Stover Novelty Works	43
Strelinger & Co., Chas. A	42
Stuart's Foundry & Machine Works, R. J	48
Syracuse Twist Drill Co	10
Taunton Locomotive Mfg. Co	43
Timolat, J. G	2
Toledo Machine & Tool Co	4
Toomey, Frank	8
Torrington Mfg. Co	2
Trenton Iron Co	48
Trump Bros. Machine Co	3
Vitrified Wheel Co	40
Warner & Swasey	48
Waterbury-Farrel F'dry & Mach. Co	47
Waterbury Machine Co., The	3
Watson-Stillman Co., The	6
Weber Gas & Gasoline Engine Co	46
Webster Mfg. Co	40
Webster & Perks Tool Co	40
Wedderburn & Co., John	48
Wells Bros. & Co	2
Weston Engine Co	46
Wetherill Machine Co., James P	4
Whitcomb Mfg. Co	43
Whiton Machine Co., D. E	3
Wiley & Sons, John	39
Wiley & Russell Mfg. Co	39
Wilkinson & Co., A. J	2
Wilkinson Co., The	11
Wilson, W. A	3
Wolverine Motor Works	46
Woodward & Rogers	45
Worcester Machine Screw Co	47
Wrigley, T	40
Wyke & Co., J	12
Wyman & Gordon	48

If you will straighten and cut the Wire you use, you will in a short time pay for an

Automatic Wire Straightening and Cutting Machine.

Upon application we will furnish data of the number of feet cut per minute on the machine illustrated.



AUTOMATIC WIRE STRAIGHTENING AND CUTTING MACHINE.

John Adt & Son,

F. B. Shuster, Prop.,

New Haven, Conn., U. S. A.

Also Builders of Roll and Rotary Straighteners, Riveting Machines, Butt Milling Machines, Butt Drilling Machines, Foot Presses, Sprue Cutters, Machinery and Tools for the Manufacture of Hardware, Sheet Metal, Saddlery, and Wire Goods.

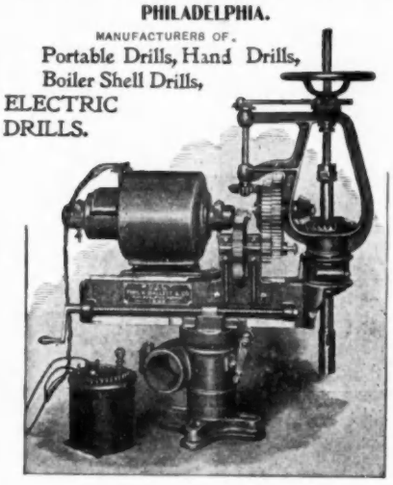
Address, Machine Department.

Thos. H. Dallett & Co.

PHILADELPHIA.

MANUFACTURERS OF

Portable Drills, Hand Drills, Boiler Shell Drills, ELECTRIC DRILLS.



Planer Centers Turret Lathes, Speed Lathes, Pattern Makers' Lathes, Engine Lathes, and Special Machinery of all descriptions

MANUFACTURED BY

Fay & Scott, Dexter, Me., U.S.A.

ARE NOTED FOR HOW WELL THEY ARE MADE AND HOW WELL THEY WILL MAKE.

Write for Catalogue "D."

Buyers' Finding List.

ADDING MACHINES.
Grant Calculating Machine Co., Boston, Mass

AIR COMPRESSORS.
Rand Drill Co., New York.

ASBESTOS CEMENT FELTING.
Johns Mfg. Co., H. W., New York.

AUGER BITS.
Adams, A. L., Bridgeport, Conn.

BALLS, STEEL.
Cleveland Machine Screw Co., Cleveland, O.

BEARINGS, ANTI-FRICTION.
Ball Bearing Co., The, Boston, Mass.
Hyatt Roller Bearing Co., Newark, N. J.
Mossberg & Granville Mfg. Co., Providence, R. I.

BELT DRESSING.
Dixon Crucible Co., Joseph, Jersey City, N. J.

BICYCLES.
Pope Mfg. Co., Hartford, Conn.

BICYCLE TOOLS.
American Gas Furnace Co., New York.
Bickford Drill & Tool Co., Cincinnati, O.
Bliss Co., E. W., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Mach. Screw Co., Cleveland, O.
Davis & Egan Mach. Tool Co., Cincinnati, O
Diamond Machine Co., Providence, R. I.
Ferracute Machine Co., Bridgeton, N. J.
Garvin Machine Co., New York.
Geometric Drill Co., New Haven, Conn.
Hill, Clarke & Co., Boston, Mass.
McCabe, J. J., New York.
Mossberg & Granville Mfg. Co., Providence, R. I.
Niles Tool Works Co., Hamilton, O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Wells Bros. & Co., Greenfield, Mass.
Wilkinson Co., The, Chicago, Ill.
Woodward & Rogers, Hartford, Conn.

BICYCLE TUBING.
Armstrong Bros.' Tool Co., Chicago, Ill.
Pope Tube Co., Hartford, Conn.

BLOWERS.
American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Boston, Mass.

BOILERS, STEAM.
Weston Engine Co., Painted Post, N. Y.
Wetherill Mach. Co., James P., Chester, Pa.

BOLT CUTTERS.
Acme Machinery Co., Cleveland, O.
Becher, J. A., Mishawaka, Ind.
Davis & Egan Machine Tool Co., Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Detrick & Harvey Machine Co., Baltimore, Md.
Geometric Drill Co., New Haven, Conn.
Hill, Clarke & Co., Boston, Mass.
National Machinery Co., Tiffin, O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Reece, Edw. J., Greenfield, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.
Webster & Perks Tool Co., Springfield, O.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

BOOKS.
Audel & Co., Theo., New York.
Baird & Co., Henry Carey, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Grant Gear Works, Boston, Mass.
Henley & Co., Norman W., New York.
Merriam Co., S. & G., Springfield, Mass.
Philadelphia Book Co., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.
Wiley & Sons, John, New York.

BORING AND TURNING MILLS.
Betts Machine Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, O.
Bickford, H., Lakeport, N. H.
Bullard Machine Tool Co., Bridgeport, Conn.
Davis & Egan Machine Tool Co., Cincinnati, O.
Newark Machine Tool Works, Newark, N. J.
Niles Tool Works Co., Hamilton, O.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., William, Philadelphia, Pa.

BORING AND TURNING TOOLS FOR GEOMETRIC SHAPES.
Geometric Drill Co., New Haven, Conn.

BOXES.
Prvibil, P., New York

BRASS WORK, SPECIAL.
Nolte Brass Co., Springfield, O.

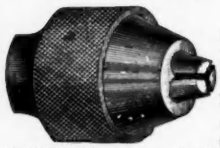
BRUSHES.
Buchel Machine Works, New Orleans, La.

BUSHINGS.
New Process Raw Hide Co., Syracuse, N. Y.

CALIPERS.
Brown & Sharpe Mfg. Co., Providence, R. I
Standard Tool Co., Athol, Mass.
Strelinger & Co., Chas. A., Detroit, Mich.
Wilkinson & Co., A. J., Boston, Mass.

CAMS.
Newark Machine Tool Works, Newark, N. J.

A Twenty Years' Record!



THIS CHUCK has been continuously advertised in the **American Machinist** since the first issue of the paper.

In spite of imitations the largest number of sales of the Almond Drill Chuck were made during the year 1895.

T. R. ALMOND,
83 Washington Street, Brooklyn, N. Y.

SPECIAL PRESSES AND DIES
FOR ALL KINDS OF BICYCLE WORK.
FERRACUTE MACHINE CO.
New Catalogue. BRIDGETON, N. J., U. S. A.

SWEET'S
Measuring Machine.
The only micrometer that will not lose its accuracy by wear.
Satisfaction Guaranteed,
SYRACUSE TWIST DRILL CO.,
Syracuse, N. Y.

Vertical Milling Machine
...AND...
Drill Press Combined
Send for Illustrated Circular "D," describing this and other specialties manufactured by
R. M. CLOUGH, New Haven, Conn.

PLAIN MILLER FOR BICYCLE MANUFACTURERS
And REPAIRERS.
A very useful, up-to-date machine, at a small cost, made in various sizes. Prompt shipments. Write for Illustrated Circular "A," dimensions and prices.
FRAZER MACHINE WORKS,
14-16 Frankfort St., Cleveland, O., U.S.A.

BETHLEHEM ROTARY SHEAR
Will cut Sheet Metal and Plates ¼ inch thick or less, in circles, curves or straight away, any length, any width up to 31 inches.
BETHLEHEM FOUNDRY AND MACHINE COMPANY,
South Bethlehem, Pa.

NEW PROCESS RAW HIDE PINIONS
For Electric Motors and all High-speed Machinery.
NOISELESS. CLEANLY. DURABLE.
New Process Raw Hide Bushings.
The New Process Raw Hide Co.
PATENTEES AND SOLE MANUFACTURERS,
SYRACUSE, N. Y., U. S. A.

CARBORUNDUM.
Carborundum Co., Niagara Falls, N. Y.

CASTINGS, BRASS.
Nolte Brass Co., Springfield, O.

CASTINGS, IRON.
Builders Iron Foundry, Providence, R. I.
Shriver & Co., T., New York.

CASTINGS, PHOSPHOR BRONZE.
Nolte Brass Co., Springfield, O.

CASTINGS, STEEL.
Reliance Steel Castings Co., Ltd., Pittsburgh, Pa.

CEMENTS, ETC.—FIRE-PROOF.
Johns Mfg. Co., H. W., New York.

CENTERING DRILL.
Slocomb & Co., J. T., Providence, R. I.

CHUCKS, DRILL.
Almond, T. R., Brooklyn, N. Y.
Cushman Chuck Co., Hartford, Conn.
Dawson & Goodwin, Chicago, Ill.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Oneida Mfg. Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Clayville, N. Y.
Prentiss Tool & Supply Co., New York.
Skinner Chuck Co., New Britain, Conn.
Trump Bros. Machine Co., Wilmington, Del.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Whiton Machine Co., D. E., New London, Conn.

CHUCKS, LATHE.
Cushman Chuck Co., Hartford, Conn.
Dawson & Goodwin, Chicago, Ill.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Oneida Mfg. Chuck Co., Oneida, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Pratt Chuck Co., Clayville, N. Y.
Prentiss Tool & Supply Co., New York.
Skinner Chuck Co., New Britain, Conn.
Whiton Machine Co., D. E., New London, Conn

CLUTCHES, FRICTION.
Bliss Co., E. W., Brooklyn, N. Y.
Evans Friction Cone Co., Boston, Mass.
New Haven Mfg. Co., New Haven, Conn.

CONDENSERS.
Conover Mfg. Co., New York.

CORUNDUM WHEELS.
Hampden Corundum Wheel Co., Brightwood, Mass.
Vitrified Wheel Co., Westfield, Mass.

COUPLINGS.
Stuart's Foundry and Machine Works, R. J., New Hamburgh, N. Y.

COVERINGS, NON-CONDUCTING, PIPE AND BOILER.
Johns Mfg Co., H. W., New York.

CRANES.
Harrington, Son & Co., E., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

CUTTING-OFF MACHINES.
Armstrong Mfg. Co., The, Bridgeport, Conn.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Mach. Co., So. Sudbury, Mass.

DIES, SCREW-CUTTING.
Acme Machinery Co., Cleveland, O.
Besly & Co., Chas. H., Chicago, Ill.
Detrick & Harvey Machine Co., Baltimore, Md.
Geometric Drill Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Montgomery & Co., New York.
National Chuck Co., New York
Pratt & Whitney Co., Hartford, Conn.
Strelinger & Co., Chas. A., Detroit, Mich.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass

DRAWING INSTRUMENTS, ETC.
Alteneder & Sons, T., Philadelphia, Pa.
Keuffel & Esser Co., New York.

DRILLING MACHINES.
Adt & Son, John, New Haven, Conn.
Aurora Tool Works, Aurora, Ind.
Barnes Co., W. F. & John, Rockford, Ill.
Baush & Harris Mch. Tool Co., Holyoke, Mass.
Betts Machine Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, O.
Blaisdell & Co., P., Worcester, Mass.
Dallett & Co., Thos. H., Philadelphia, Pa.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Dietz, Schumacher & Boye, Cincinnati, O.
Dwight Slate Machine Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Barker & Co., Cleveland, O.
Fox Machine Co., Grand Rapids, Mich.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Hamilton Machine Tool Co., Hamilton, O.
Harrington, Son & Co., E., Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
McCabe, J. J., New York.

DRILLING MACHINES—Continued.

Mewer Tool Co., Portland, Me.
Montgomery & Co., New York.
Mossberg & Granville Mfg. Co., Providence, R. I.
New Haven Mfg. Co., New Haven, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Norton & Jones Machine Tool Works, Plainville, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa
Sibley & Ware, South Bend, Ind.
Snyder, J. E., Worcester, Mass.
Stover Novelty Works, Freeport, Ill.
Strelinger & Co., Chas. A., Detroit, Mich
Timolat, J. G., New York.
Warner & Swasey, Cleveland, O.
Wells Bros. & Co., Greenfield, Mass.
Wilkinson & Co., A. J., Boston, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Woodward & Rogers, Hartford, Conn.

DRILL GAGE.

Wyke & Co., J., East Boston, Mass.

DRILL RODS.

Abbott, Wheelock & Co., Boston, Mass.
Crescent Steel Co., Pittsburgh, Pa.

DRILLS, TWIST.

Besly & Co., Chas. H., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
McFadden Co., Philadelphia, Pa.
Montgomery & Co., New York.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.

DROP FORGINGS.

Wyman & Gordon, Worcester, Mass.

DYNAMOS.

Crocker-Wheeler Electric Co., New York
General Electric Co., New York.

DYNAMOS, NICKEL-PLATING.

Diamond Machine Co., Providence, R. I.

ELECTRIC MACHINERY.

Crocker-Wheeler Electric Co., New York
General Electric Co., New York.

ELEVATORS.

Albro-Clem Elevator Co., Philadelphia, Pa.

EMERY WHEEL DRESSERS.

Wrigley, T., Chicago, Ill.

EMERY WHEELS.

Besly & Co., Chas. H., Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Hampden Corundum Wheel Co., Brightwood, Mass.
Montgomery & Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Sterling Emery Wheel Co., Tiffin, O.
Strelinger & Co., Chas. A., Detroit, Mich
Vitrified Wheel Co., Westfield, Mass.

ENGINES, GAS AND GASOLINE.

Daimler Motor Co., "Steinway," Long Island City, N. Y.
Mietz & Weiss, New York.
Otto Gas Engine Works, Philadelphia, Pa.
Pierce Engine Co., Racine, Wis.
Prouty Co., The, Chicago, Ill.
Springfield Gas Engine Co., Springfield, O.
Weber Gas and Gasoline Engine Co., Kansas City, Mo.
Webster Manufacturing Co., Chicago, Ill.
Wolverine Motor Works, Grand Rapids, Mich.

ENGINES, STEAM.

Ames Iron Works, Oswego, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Forbes & Co., W. D., Hoboken, N. J.
Frick Co., The, Waynesboro, Pa.
Keystone Engine & Mach. Works, Phila., Pa.
Weston Engine Co., Painted Post, N. Y.
Wetherill Mach. Co., James P., Chester, Pa.

FEED WATER HEATERS AND PURIFIERS.

Taunton Locomotive Mfg. Co., Taunton, Mass

FILES.

Arcade File Works, New York.
Besly & Co., Chas. H., Chicago, Ill.
McFadden Co., Philadelphia, Pa.
Montgomery & Co., New York.
Nicholson File Co., Providence, R. I.
Strelinger & Co., Chas. A., Detroit, Mich.

FIRE-PROOF CONSTRUCTION MATERIALS.

Johns Mfg. Co., H. W., New York.

FORGES.

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Wilkinson Co., The Chicago, Ill.

FRICTION CONES.

Evans Friction Cone Co., Boston, Mass.

FURNACES.

American Gas Furnace Co., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.

GAGES.

Brown & Sharpe Mfg. Co., Providence, R. I.
Coffin & Leighton, Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Wyke & Co., J., East Boston, Mass.

THE WORLD RENOWNED

PENBERTHY

AUTOMATIC INJECTOR,

Starts Lower,
Works Higher,
Lifts Further,
Handles Hotter Water

THAN ANY OTHER AUTOMATIC INJECTOR.

SEND FOR CATALOG.

PENBERTHY INJECTOR CO.

124 Seventh Street, DETROIT, MICH.

Largest Injector Manufacturers in the World.

A NEW CATALOGUE

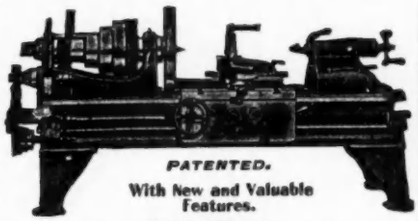
of Fine Machinists' Tools has just been issued by J. T. SLOCOMB & CO., Providence, R. I., and it should be in the hands of every thorough mechanic and believer in good tools in the best mechanical work. Ask for new Catalogue "E."

BEVEL GEARS

Cut Theoretically Correct.
Special facilities for cutting worm wheels.

HUGO BILGRAM,
Machinist,
440 N. 12th St., Phila., Pa.

HIGH CLASS ENGINE LATHES.



PATENTED.
With New and Valuable Features.

MADE ONLY BY
THE BRADFORD MILL COMPANY,
CINCINNATI, OHIO, U. S. A.

Catalogue "A" describes our Lathes, sent on application.

ENGLAND—Chas. Churchill & Co., Ltd., London & Birmingham.
NEW YORK—Garvin Machine Co., Spring and Varick Sts.

LATHES,
FOOT POWER MACHINERY OF ALL KINDS,
Bicycle Repair Shop Tools, Vises, Forges, Screw Plates, Taps and Dies, Brazers, Wheel Truers, etc. Scroll Saws and Fancy Woods. Send 4c for Illustra'd Catalog.
THE WILKINSON CO., 83 Randolph Street, Chicago.

P. BLAISDELL & CO.,
Manufacturers of
Machinists' Tools
Worcester, Mass.
London Agts.: C. W. BURTON, GRIFFITHS & Co.

LE BLOND LATHES 12" 14" 16"
Pearl & Plum
CIN'TI. O.

GEAR CUTTERS.

Brown & Sharpe Mfg. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hill, Clarke & Co., Boston, Mass.
McCabe, J. J., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whiton Mach. Co., D. E., New London, Conn.

GEARS.

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Grant Gear Works, Boston, Mass.
New Process Raw Hide Co., Syracuse, N. Y.
Shriver & Co., T., New York.

GRAPHITE.

Dixon Crucible Co., Joseph, Jersey City, N. J.

GRINDING AND POLISHING MACHINES.

Besly & Co., Chas. H., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Diamond Machine Co., Providence, R. I.
Garvin Machine Co., New York.
Hill, Clarke & Co., Boston, Mass.
Landis Bros., Waynesboro, Pa.
Norton Emery Wheel Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.
Wells Bros. & Co., Greenfield, Mass.

GRINDERS, CENTER.

Barker & Co., William, Cincinnati, O.
Diamond Machine Co., Providence, R. I.
Trump Bros. Machine Co. Wilmington, Del.

GRINDING MACHINE, CUTTER.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Davis & Egan Machine Tool Co., The Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Garvin Machine Co. New York.
Hill, Clarke & Co., Boston, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Wells Bros. & Co., Greenfield, Mass.
Woodward & Rogers, Hartford, Conn.

GRINDING MACHINE, SURFACE.

Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
Woodward & Rogers, Hartford, Conn.

GRINDING MACHINE, UNIVERSAL.

Brown & Sharpe Mfg. Co., Providence R. I.
Diamond Machine Co., Providence, R. I.
Landis Bros. Waynesboro, Pa.

HACK SAWS.

Besly & Co., Chas. H., Chicago, Ill.
Montgomery & Co., New York.
Q. & C. Co., Chicago, Ill.
Stover Novelty Works, Freeport, Ill.
Strelinger & Co., Chas. A., Detroit, Mich.

HAMMERS, DROP.

Long & Allstatter Co., Hamilton, O.
Miner & Peck Mfg. Co., New Haven, Conn
Mossberg & Granville Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Stiles & Fladd Press Co., Watertown, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.

HAMMERS, POWER.

Bremer Machine Co., G. J., Kalamazoo, Mich.
Hill Clarke & Co., Boston, Mass.

HANGERS.

Pryibil, P., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

HOISTS.

Harrington, Son & Co., E., Philadelphia, Pa.
Maris Bros., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

HYDRAULIC MACHINERY.

The Watson-Stillman Co., New York.

INDICATORS.

Ashcroft Mfg. Co., New York.

INJECTORS.

Penberthy Injector Co., Detroit, Mich.
Rue Mfg. Co., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

JACKS, LEVELING.

Newark Machine Tool Works, Newark, N. J.

KEY-SEATER.

Burr & Sons, John T., Brooklyn, N. Y.

KEYWAY CUTTER.

Baker Bros., Toledo, O.

LATHES (see also Turret Lathes).

Barnes Co., W. F. & John, Rockford, Ill.
Blaisdell & Co., P., Worcester, Mass.
Bradford Mill Co., The, Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Machine Tool Co., Bridgeport, Conn.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Dietz, Schumacher & Boye, Cincinnati, O.
Fay & Scott, Dexter, Me.
Fifield Tool Co. Lowell Mass.
Fitchburg Machine Works, Fitchburg, Mass.

LATHES—Continued.
Flather & Co., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., E., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
Le Blond, R. K., Cincinnati, O.
McCabe, J. J., New York.
McFadden Co., Philadelphia, Pa.
New Doty Mfg. Co., Janesville, Wis.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Sebastian Lathe Co., Cincinnati, O.
Sebastian-May Co., Sidney, O
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark, John, Boston, Mass
Torrington Mfg. Co., Torrington, Conn.
Wells Bros. & Co., Greenfield, Mass.

MACHINISTS' TOOLS AND SUPPLIES.
Armstrong Bros.' Tool Co., Chicago, Ill.
Montgomery & Co., New York.
Sawyer Tool Co., Athol, Mass.
Standard Tool Co., Athol Mass.

MILLING ATTACHMENT.
Adams Co., The, Dubuque, Iowa.

MILLING CUTTERS.
Brown & Sharpe Mfg. Co., Providence R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Erlandsen, J., New York.
Garvin Machine Co., New York.
Reinecker, J. E., Chemnitz-Gablenz, Germany.

MILLING MACHINES.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clough, R. M., New Haven, Conn.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Forbes & Co., W. D., Hoboken, N. J.
Fraser Machine Works, Cleveland, O.
Garvin Machine Co., New York.
Hill, Clarke & Co., Boston, Mass.
McCabe, J. J., New York.
Mergenthaler & Co., Ott., Baltimore, Md.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Reed Co., F. E., Worcester, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Waterbury-Farrel Foundry & Machine Co Waterbury, Conn

MOLDING MACHINES.
Tabor Mfg. Co., Elizabeth, N. J.

MOTORS, ELECTRIC.
Crocker-Wheeler Electric Co., New York.
Dallett & Co., Thos. H., Philadelphia, Pa.
General Electric Co., New York.

NEEDLE WIRE.
Abbott, Wheelock & Co., Boston, Mass.

PACKING.
Jenkins Bros., New York.
Johns Mfg. Co., H. W., New York.

PAINTS, FIRE-PROOF.
Johns Mfg. Co., H. W., New York

PATENT ATTORNEYS.
Bacon, L. Seward, Washington, D. C.
Bates, H. H., Washington, D. C.
Dyer & Driscoll, New York.
Gooch, Charles J., Washington, D. C.
Welderburn & Co., John, Washington, D. C.

PATTERN LETTERS.
Montgomery & Co., New York.
Wells, Heber, New York.

PERFORATED METALS.
Harrington & King Perforating Co., The, Chicago, Ill.

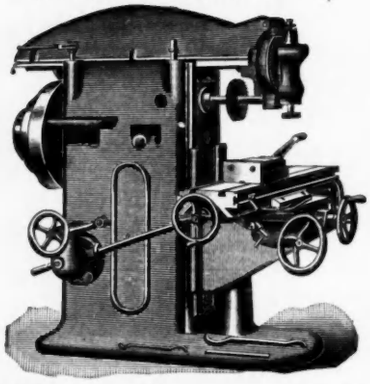
PHOSPHOR BRONZE.
Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

PIPE CUTTING AND THREADING MACHINES.
Armstrong Mfg. Co., The, Bridgeport, Conn.
Curtis & Curtis, Bridgeport, Conn.
Dawson & Goodwin, Chicago, Ill.
Derrick & Harvey Machine Co., Baltimore, Md.
Geometric Drill Co., New Haven, Conn.
Hill, Clarke & Co., Boston, Mass.
National Machinery Co., Tiffin, O.
Saunders' Sons, D., Yonkers, N. Y.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

PIPE FITTINGS.
Kelly & Jones Co., The, New York.

PLANERS.
Betts Machine Co., Wilmington, Del
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Garvin Machine Co., New York.
Gray Co., G. A., Cincinnati, O.
McCabe, J. J., New York.

Ott. Mergenthaler & Co.,
BALTIMORE, MD.
MECHANICAL ENGINEERS AND MACHINISTS.
INVENTORS OF THE LINOTYPE.



Milling Machines
SPEED LATHES, SLIDE RESTS, MANDRELS, etc., Adjustable and Solid
Reamers.
All Kinds of SPECIAL and AUTO-MACHINERY Made to Order.
PRICES AND PARTICULARS ON APPLICATION.

PATENT UNIVERSAL
SCREW-CUTTING
CENTRE, DEPTH, ANGLE, AND TWIST DRILL GAGE
J. WYKE & CO. E. BOSTON MASS. U.S.A.
MFR'S FINE MACHINISTS TOOLS.
FOREIGN AGTS.
CHAS CHURCHILL & CO. CROSS ST. LONDON ENGLAND
SCHUCHARDT & SCHÜTTE, SPANDAUER STRASSE BERLIN, GERMANY.
SEND FOR LISTS

Drop Hammers, Presses, Special Mach'y Dies.
THE STILES & FLADD PRESS CO.,
WATERTOWN, N. Y.

McFADDEN COMPANY,
TAPS & DIES · TWIST DRILLS · CHUCKS · MACHINE SCREWS · LATHES · FILES · STEEL · TOOL STUBS
TOOLS
No. 722 Arch St., PHILADELPHIA, PA.

E. W. BLISS CO.
1 Adams Street, BROOKLYN, N. Y.
CHICAGO: 96 W. Wash'n St.
Owners of THE STILES & PARKER PRESS CO.

PRESSES,
DIES and SPECIAL MACHINERY
FOR ALL
Sheet Metal Work.
400-PAGE CATALOGUE.
DROP FORGING PLANTS.
Correspondence Solicited.
No. 74 "STILES" Straight Sided Press.
Bicycle and Electrical Tools.

PLANERS—Continued.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O
Niles Tool Works Co., New York
Pratt & Whitney Co., Hartford, Conn
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb Mfg. Co., Worcester, Mass.
Wilson, W. A., Rochester, N. Y.

PLANER CENTERS.
Fay & Scott, Dexter, Me.

POLISHING WHEELS.
Builders Iron Foundry, Providence, R. I.
Diamond Machine Co., Providence, R. I.

PRESSES, DIES, ETC.
Adt & Son, John, New Haven, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Machine Co., G. J., Kalamazoo, Mich.
Ferracute Machine Co., Bridgeton, N. J.
McCabe, J. J., New York.
Mossberg & Granville Mfg. Co., Providence, R. I.
New Doty Mfg. Co., Janesville, Wis.
Stiles & Fladd Press Co., Watertown, N. Y.
Stiles & Parker Press Co., Brooklyn, N. Y.
Toledo Machine & Tool Co., The, Toledo, O.

PUBLICATIONS.
Home Study, Scranton, Pa.

PUMPING MACHINERY.
Deane Steam Pump Co., Holyoke Mass.
Wetherill Mach. Co., James P., Chester, Pa.

PUNCHES AND SHEARS.
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Machine Co., G. J., Kalamazoo, Mich.
Buffalo Forge Co., Buffalo, N. Y
Davis & Egan Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Hamilton, O.
McCabe, J. J., New York
Mossberg & Granville Mfg. Co., Providence, R. I.
New Doty Mfg. Co., Janesville, Wis.
Waterbury-Farrel Foundry & Machine Co., Waterbury Conn.
Watson-Stillman Co., The, New York.

RAW HIDE.
New Process Raw Hide Co., Syracuse, N. Y.

REAMERS.
Cleveland Twist Drill Co., Cleveland, O.
Mergenthaler & Co., Ott., Baltimore, Md.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wells Bros. & Co., Greenfield, Mass
Wiley & Russell Mfg. Co., Greenfield, Mass.

RIVETING MACHINE.
Adt & Son, John, New Haven, Conn.

ROCK DRILLS.
Rand Drill Co., New York.

ROLLING MILLS.
Mossberg & Granville Mfg. Co. Providence R. I.

ROOFING ASBESTOS.
Johns Mfg. Co., H. W., New York.

RULES, GRADUATED STEEL.
Coffin & Leighton, Syracuse, N. Y.
Darling, Brown & Sharpe, Providence, R. I.
Sawyer Tool Co., Athol, Mass.
Standard Tool Co., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

SAWS.
Q. & C. Co., Chicago, Ill.

SAWING MACHINES, METAL.
Q. & C. Co., Chicago, Ill.

SCHOOLS.
Columbia University, New York.
International Correspondence Schools, Scranton, Pa.

SCREW MACHINES (see Turret Lathes).

SCREWS, MACHINE.
Cleveland Machine Screw Co., Cleveland, O.
Flather & Co., Nashua, N. H
McFadden Co., Philadelphia, Pa.
Worcester Machine Screw Co., Worcester, Mass

SCREW PLATES.
Machinists' Supply Co., Chicago, Ill.
Reece, Edw. J., Greenfield, Mass.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wilkinson Co., The, Chicago, Ill.

SCREWS.
Cleveland Machine Screw Co., Cleveland, O.
Worcester Mach. Screw Co., Worcester, Mass.

SEPARATORS, STEAM.
Keystone Engine and Machine Works, Philadelphia, Pa.

SHAFTING, ETC.
Cumberland Iron & Steel Shafting Co., Cumberland, Md.
Pryibil, P., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

SHAPERS.
Betts Machine Co., Wilmington, Del.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Fitchburg Machine Works, Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Fox Machine Co., Grand Rapids, Mich.
Garvin Machine Co., New York.

SHAPERS—Continued.
Gould & Eberhardt, Newark, N. J.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co. Boston, Mass.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O.
Pratt & Whitney Co., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

SHEARS, ROTARY.
Bethlehem Fdy & Machine Co., South Bethlehem, Pa.

SIGHT FEED LUBRICATORS.
Kelly & Jones Co., The, New York.

SLOTTERS.
Betts Machine Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

SOLDERING FLUID.
Elliott Chemical Works, Newton, Mass.

SPECIAL MACHINERY.
Bliss Co., E. W., Brooklyn, N. Y.
Bremer Machine Co., G. J., Kalamazoo, Mich.
Geometric Drill Co., New Haven, Conn.
McMullin Mfg. Co., F. R., Chicago, Ill.
Ott, Mergenthaler & Co., Baltimore, Md.
Toledo Machine & Tool Co., The, Toledo, O.
Wetherill Machine Co., James P., Chester, Pa.

STEEL.
Abbott Wheelock & Co., Boston, Mass.
Crescent Steel Co., Pittsburgh, Pa.
Jones & Co., B. M., Boston, Mass.
McFadden Co., Philadelphia, Pa.

TAPPING MACHINES.
Woodward & Rogers, Hartford, Conn.

TAPS AND DIES.
McFadden Co., Philadelphia, Pa.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg Co., Greenfield Mass.
Wilkinson Co., The, Chicago, Ill.

THREADING MACHINES.
Webster & Perks Machine Tool Co., Springfield, O.

TOOL HOLDERS.
Armstrong Bros.' Tool Co., Chicago, Ill.
Gould & Eberhardt, Newark, N. J.

TRAMWAYS, OVERHEAD.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.

TUBING, FLEXIBLE.
Almond, T. K., Brooklyn, N. Y.

TURRET LATHES (Screw Machines).
Bardons & Oliver, Cleveland, O.
Bradford Mill Co., The, Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Machine Tool Co., Bridgeport, Conn.
Cleveland Machine Screw Co., Cleveland, O.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dawson & Goodwin, Chicago, Ill.
Dreses, Mueller & Co., Cincinnati, O.
Garvin Machine Co., New York.
Hill, Clarke & Co., Boston, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
McCabe, J. J., New York.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Warner & Swasey, Cleveland, O.

VALVES.
Jenkins Bros., New York.
Kelly & Jones Co., The, New York.

VENTILATING FANS.
Backus Water Motor Co., Newark, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant & Co., B. F., Boston, Mass.

VENTILATORS.
Pancoast Ventilator Co., Philadelphia, Pa.

VISES.
Hill Clarke & Co., Boston, Mass.
McCabe J. J. New York
McFadden Co., Philadelphia, Pa.
Niles Tool Works Co., New York.
Seelinger & Co., Chas A., Detroit, Mich.
Wilkinson Co., The, Chicago, Ill.
Wyman & Gordon Worcester, Mass.

WATER MOTORS.
Backus Water Motor Co., Newark, N. J.

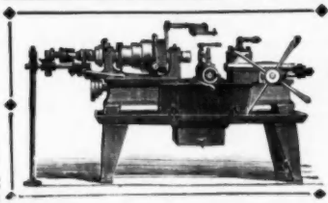
WIRE MACHINERY.
Adt & Son, John, New Haven, Conn.
Goodyear, S. W. Waterbury Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury Conn.
Waterbury Machine Co., Waterbury, Conn.

WIRE ROPE (Iron and Steel).
Trenton Iron Co., The, Trenton, N. J.

WOODWORKING MACHINERY.
Barnes Co., W. F. & John Rockford, Ill.
J. A. Fay & Egan Co., Cincinnati, O.
Pryibil P., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y

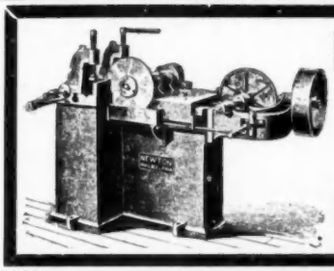
REG. TRADE MARKS
"Phosphor Bronze"
DELTA

THE PHOSPHOR BRONZE SMELTING CO. LIMITED,
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U.S.



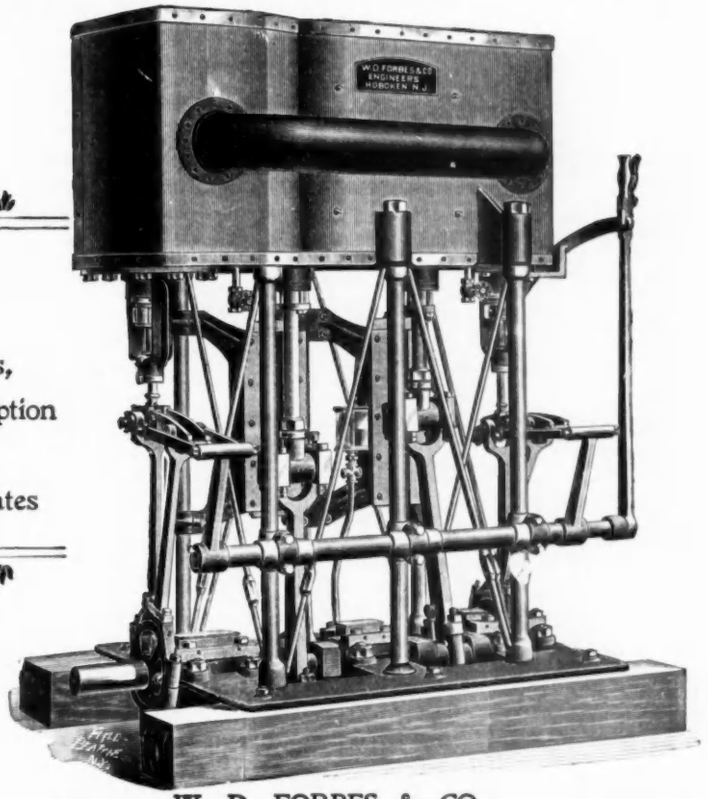
UP TO THE MARK.
SCREW AND TURRET
MACHINERY. HUB MACHINES,
All Sizes and Descriptions.
DRESES, MUELLER & CO.
CINCINNATI, O.

BARDONS & OLIVER'S TURRET LATHES
LATEST IMPROVED
With Bicycle Hub Forming and other Attachments, are in the lead and finding favor everywhere. Interesting Literature on Application.
COMPLETE OUTFITS FURNISHED.
BARDONS & OLIVER,
CLEVELAND, OHIO, U. S. A.



NEWTON MACHINE TOOL WORKS,
PHILADELPHIA.
COLD SAW
Cutting-Off Machines.

YACHT ENGINES.



Send for Photos, Description and Estimates

W. D. FORBES & CO.,
1302 HUDSON STREET, HOBOKEN, N. J.
Two blocks from Fourteenth Street Ferry.

Niles Tool Works Co.

Engineers and Builders.

MACHINE TOOLS.

Hamilton, O., U.S.A.

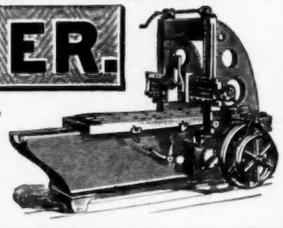
Main Office and Works.

Branches: New York, Boston, Chicago, Philadelphia, Pittsburgh.

All Types and Sizes.

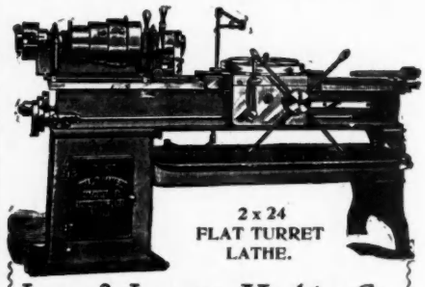
PLEASE MENTION THIS PAPER WHEN WRITING.

THE GRAY PLANER.



THE G. A. GRAY CO., CINCINNATI, O.

These Machines are sold by the following Agents:
J. A. FAY & EGAN CO., 34 South Canal Street, CHICAGO.
STRONG, CARLISLE & TURNEY CO., 193 Bank Street, CLEVELAND, O.
E. A. KINSEY & CO., 331 West Fourth Street, CINCINNATI O.
THOS. K. CAREY & BROS. CO., 26 Light Street, BALTIMORE, MD.
J. J. McCABE, 14 Dey Street, NEW YORK CITY.
SCHUCHARDT & SCHUTTE, BERLIN, C., Germany, and VIENNA Austria.
CHAS. CHURCHILL & CO., LTD., LONDON and BIRMINGHAM, England.



2 x 24
FLAT TURRET
LATHE.

Jones & Lamson Machine Co.

Springfield, Vt., U. S. A.

SOLE BUILDER OF THE

Flat Turret Lathe.

FOREIGN REPRESENTATIVES:
M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany.
Adolphe Janssens, 16 Place de la Republique, Paris, France.
Charles Churchill & Co., 9-15 Leonard St., Finsbury, London, E.C., and 6 Albert St., Birmingham, Eng.
Henry Kelley & Co., 26 Pall Mall, Manchester, Eng.

SEND FOR ILLUSTRATED CATALOGUE.

NICHOLSON FILE CO.

Our PAST RECORD the best GUARANTEE for the FUTURE.

BOX 188, PROVIDENCE, R. I., U. S. A.

How to Save Money in Blacksmith Shops.

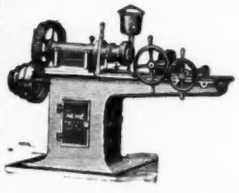
By ORVILLE H. REYNOLDS.

. . . ILLUSTRATED pamphlet showing operations done by dies and formers by means of bulldozer and helve hammers. Ought to be in the hands of every foreman blacksmith. Published by LOCOMOTIVE ENGINEERING, 256 Broadway, New York. Price 25 cents.

THE ACME Machinery Co.

CLEVELAND, O.

MANUFACTURERS OF ACME BOLT AND RIVET HEADERS, ACME SINGLE AND DOUBLE AUTOMATIC BOLT CUTTERS, cutting from 1-8 in. to 6 in. diam. ALSO SEPARATE HEADS AND DIES.



William Sellers & Co. Incorp. PHILADELPHIA.

HAVE YOU EXAMINED ?

THE NEW TOOL GRINDER No. 2?
THE CENTRIFUGAL SAND MIXER?
THE VICARS' MECHANICAL STOKER?

These may be seen in operation at our establishment.

Descriptive Circulars Mailed on Application.

Potter Printing Press Company.

Plainfield, N.J. October 15, 1896.

Messrs. Gould & Eberhardt,
Newark, N. J.

Gentlemen:

We have one of your 36" New Type Automatic Gear Cutters in use in our Works, and take pleasure in saying that we are highly pleased with it. It is essentially a 19th, if not a 20th Century Machine, and we will cordially recommend it to any one you may refer to us.

Yours very truly,
POTTER PRINTING PRESS CO.,
D. E. Pitwood
Sup't

JOHN LANG & SONS, JOHNSTONE, SCOTLAND.
Sole Agents on Gear Cutters for Great Britain.
SCHUCHARDT & SCHUTTE, GENERAL AGENTS,
Berlin, Germany; 17 Breitegasse, Vienna, Austria

Locomotive Engineering

is the most interesting and finest illustrated railroad paper published. Price $2.00 a year. . .

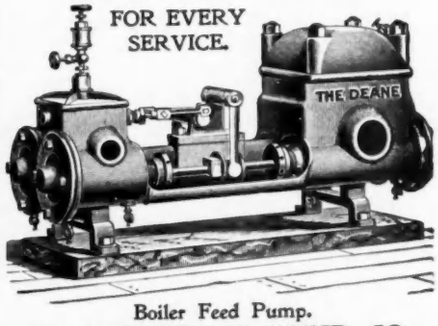
SINCLAIR & HILL, 256 Broadway, New York.

Specimen copy free

The Deane OF HOLYOKE.

STEAM PUMPS

FOR EVERY SERVICE.



Boiler Feed Pump.

DEANE STEAM PUMP CO.

HOLYOKE, MASS.

New York. Boston. Chicago.

GRANT GEARS

GEAR WHEELS CUTTING

Grant Gear Works,
125 South 11th Street, PHILADELPHIA.
6 Portland Street, BOSTON.
86 Seneca Street, CLEVELAND.

Send for Catalog.

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

▲ ▲ ▲

VOLUME 19. NEW YORK, THURSDAY, DECEMBER 3, 1896. NUMBER 49

▲ ▲ ▲

"Planed" Bevel Gear Teeth.

There appears to be much confusion and not a little positive error, even among well-informed machinists, with regard to the definition of the word "planed" when applied to the teeth of bevel gears, and an explanation, more curtailed than detailed on account of the great complexity of the subject, may be welcome to many. The fact is that the term has outlived its usefulness and is no longer descriptive in that connection.

There are four distinctly different methods now in use for cutting the teeth of bevel gears, not to mention projected methods and undeveloped inventions:

1st. The Ordinary Tooth.—This method, in use everywhere, consists in cutting the teeth with a single rotary formed cutter, which is shaped as nearly as may be, and seldom very nearly, to the proper tooth form. The single virtue of this method is that it is convenient, and convenience covers a multitude of sins. Its only defect, and it is a great one, is that by no possible means can it be made to give a tooth that is strictly correct. The working surface of the bevel gear tooth is of variable curvature, being much flatter at the large end of the tooth than at the small end, while the formed cutter with which it is shaped is invariably of fixed curvature. The result is that the tooth thus made is and can be right in but one place, and it is but seldom that it will bear close examination. The too common practice is to make it right at the end that is seen and let the rest take care of itself. With skill and unusual facilities this tooth can be fairly well made when it is small, but the defects on a large tooth are too glaring to pass anywhere.

2d. The Templet-Planed Tooth.—This method aims at the theoretically correct formation of the tooth surface, and would attain it if correctly applied; but it seldom is. It consists in guiding a planing tool by means of a previously formed templet, as roughly shown by Figure 1, so as to form the tooth surface by an envelope of straight cuts radiating from the apex of the gear, and, obviously, the shape of the tooth may be as perfect as is that of the templet. The defects of this system are four. As a means for removing metal it has the disadvantage of the planing method as compared with the milling method, and it is not economical. We do not find machines for planing the teeth of spur gears, except those of very large size, and the only reason for planing bevel teeth is that the milling cutter cannot be made to work on the templet plan. It requires a special machine of great cost and a multitude of templets for all possible shapes and numbers of teeth. The correct formation of the templet is a work of science, and the easiest and therefore most common method is to form it with circles instead of the true curves, and a not unusual method is to use a templet that was made for some similar job and therefore is "near enough." The correct formation of the templet alone will cost more than the whole cutting by other methods. Theoretically the cutting tool is a single point, but practically it has an appreciable width, and the cutting lines which form the tooth surface must be very close together to produce a good result, or in other words, the feed must be very fine. A quickly cut surface is likely to be a collection of ridges, to be commended only for its capacity for holding oil. Machines of this description are in quite general use, but have not as yet been economically applied to small teeth, and it is this form of tooth that is generally meant by the word "planed."

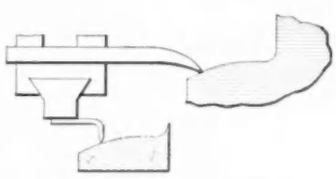


Fig. 1. Template Planed.

Fig. 2. Bilgram Planed.

Fig. 3. Planoid Milled.

3d. The Bilgram Generated Planed Tooth.—This overcomes the one great defect of the templet planer, the almost inevitable imperfections of the templet, for it has no templet. The motions of the machine are such that the perfectly straight cutting edge of the V-shaped planing tool follows the outline of a perfect tooth, resembling very closely the involute, in a manner indicated by Fig 2, but impossible to clearly describe within present limits. [The machine and its method of operation were fully illustrated and described in our issue of May 9, 1885.—Ed.] As accuracy is the result of a correct setting of the machine (not at all a difficult matter), the Bilgram-planed tooth is so nearly perfect that nothing better need be desired. A Bilgram-planed tooth is generally the most nearly perfect thing about the machine on which it is used. Outside of Mr. Bilgram's workshop there is but one Bilgram machine at present in use, and that one is owned by the Brown & Sharpe Manufacturing Company. I am informed that Mr. Bilgram now declines to sell his machines, and that the Brown & Sharpe Company were lucky enough to get their order in before he came to that determination.

4th. The Planoid Milled Tooth.—This aims to still further improve the process by retaining the practical virtues of the milling cutter as compared with the planing tool, and also the virtues of the generative method as compared with the templet method. It is, in fact, the well-known milling process with its only defect removed, and that without introducing a new defect. The process is illustrated by Fig. 3, and was fully described in this paper for June 7, 1894. The flat milling cutter is so handled by the mechanism, and without being guided by hand or templet, that its cutting surface follows the outline of a tooth curve of special form that very closely resembles the epicycloidal. The cuts are rolling cuts, square across the face of the gear and not in the direction of the length of the tooth. The only planoid bevel gear cutting machine at present in existence is in use at the Philadelphia Gear Works.

Planed Teeth.—Therefore, for the reasons above given at some length, the word "planed," to distinguish between different qualities of bevel gear teeth, has outlived its usefulness, and is both incomplete and incorrect. To give it any definite meaning it must be either "templet-

planed" or "Bilgram-planed," for the difference between those two forms is likely to be quite as great as between the "templet-planed" and the "ordinary cut" teeth. As a means for distinguishing between a good bevel gear tooth and a bad one, often its only meaning, it is a misnomer, for the quality of the product has no definite connection with the method of formation. The planoid tooth is quite as perfect as any, but the method of its formation has no connection with or resemblance to planing.

GEORGE B. GRANT.

Boston.

▲ ▲ ▲

The Construction of an Accurate Large Spur Gear.

A trial order was not long since placed with Messrs. Wm. Sellers & Co., of Philadelphia, for a notable pair of spur gears, with a contingent order for five more pairs should the first meet the specifications, which later pairs have since been delivered. The requirements were so severe that few shops in this or any other country would, we think, have undertaken the work, and we propose in this article to outline the methods employed. The gears were intended for operating the main engines of the Calumet & Hecla Mine. The pitch diameters of gear and pinion, respectively, were to be 16 feet 8 inches and 3 feet 5.3328 inches, by 15 inches face, the gears having 150 and the pinions 31 teeth. The rims of the gears only were to be supplied, as spiders were already in existence at the mine, from which gages were supplied for the boring of the rims. The special requirement which renders the gears a notable piece of work was that the teeth of gear and pinion were to work together without *shake*, these words meaning exactly what they say; that is, without *any* shake. The profile of the teeth was to be on the epicycloidal system.

In our sketch, Fig. 1 shows a plan and section of one segment of the gear, from which a clear idea of the design will be apparent.

In a piece of work of this character, accurate division of the teeth is of prime importance, and it became necessary to originate a correct index plate. This plate is shown in vertical section and partial plan in Fig. 2—a detail of the rim section being shown to an enlarged scale. The gear blank, bored and otherwise completed except for the teeth, was laid directly upon this plate, resting upon faces *a* and *b*, the gear being maintained central with the plate by ledges *d*, of which there were six turned to fit the bore of the gear rim.

The actual cutting of the teeth was done in a slotting machine with a tool having the profile of the teeth, this index plate being mounted upon a post immediately in front of the slotting machine. In this plan of work the concrete floor of the Sellers Works played an important part, as it permitted the support to be set up and sulphured in position without danger of settling or other change. The index plate was carried on friction rollers between it and the supporting block, and its central shaft was rigidly tied to the table of the slotting machine so as to maintain a fixed distance. The surface *e* rested on the table and, during the cutting of the teeth, was clamped to it. The plate and gear could thus be turned over the table, bringing the teeth under the tool in succession, the whole being clamped to the table for each cut, and the feed inward for each tooth being accomplished by the regular table feed screw. A stop block was mounted between the slotter frame column and the slide block carrying the table, by which a positively uniform depth of tooth was secured.

The index plate was graduated by lines upon the face *f*, this division being accomplished by stations set up at various points around the plate with repeated trials and corrections. It will be observed that the number of teeth is an exceedingly awkward one to handle, as it divides by two but once. Had the gear had 160 teeth, the division could have been made by successive halving down to spaces which would have contained but 5 teeth, but with the number actually dealt with, this method could not be followed. In point of fact, no halving was done, the circle being divided at the first division into five parts containing 30 teeth, each part being then further subdivided into

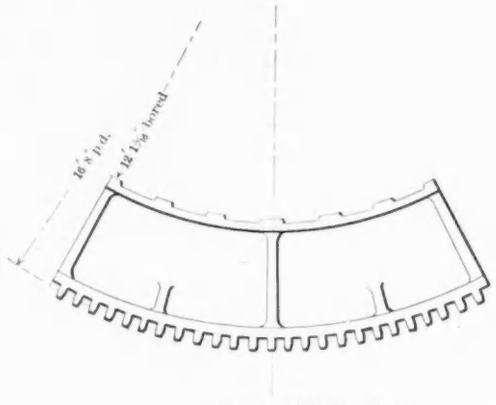


Fig. 1.—THE GEAR

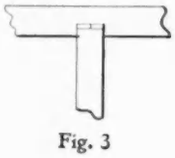


Fig. 3

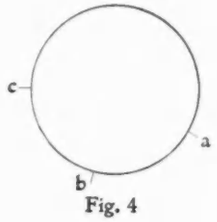


Fig. 4

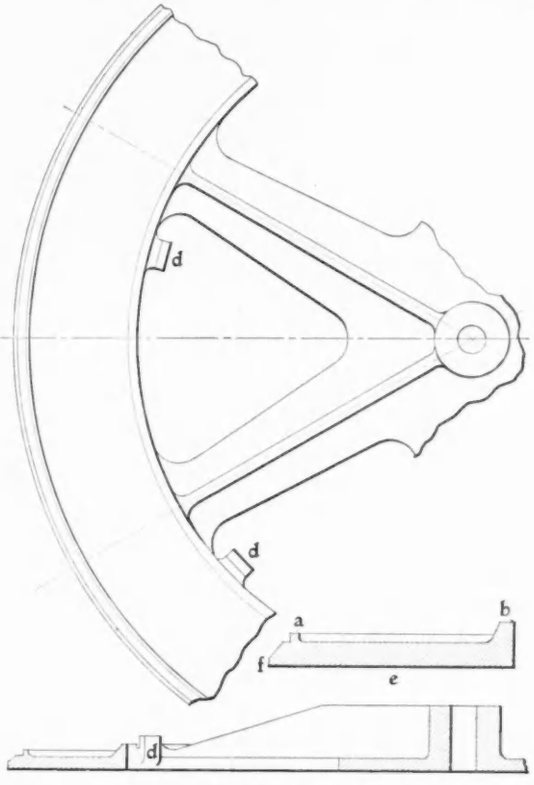


Fig. 2.—THE INDEX PLATE

American Machinist

THE CONSTRUCTION OF AN ACCURATE LARGE SPUR GEAR.

five parts containing 6 teeth, when a final division reduced it to single teeth.

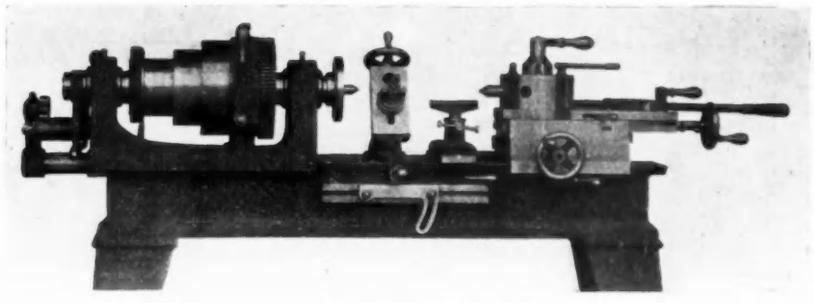
The stations set up comprised simple but firm supports carrying pieces of steel adjacent to the edge of the plate to be graduated, beveled on the edge and provided with a fine mark, as shown in the sketch, Fig. 3. The method of using these stations will be understood from Fig. 4, in which the circle represents the plate, while the marks outside the circle represent the stations. It is obvious that if these stations are truly spaced at one-fifth the circumference apart, they may be used for graduating the plate; for if, to start with, marks be made opposite *a* and *b*, the *b* mark may then be turned to *c*, and a new one be made at *a*, and so on around the circle—the result being that if the stations are correctly spaced at the beginning, the division of the circle will close at the last mark. On the contrary, if the division does not close at the last mark, the stations are not properly spaced. In other words, the stations and the plate may be made to mutually prove one another, and thus by repeated trials and with limitless patience, the plate may be finally divided and proved at the same operation. The first division into five parts being accomplished, the stations are then reset for the subdivision of these parts, and so on for the final division into single teeth. The division being accomplished, the gear blank is mounted on the plate, and the stations are then used as index points in turning the blank from tooth to tooth under the slotting tool. The division could of course be accomplished by two stations instead of three, but the use of three stations is an additional check. After the division is completed, one station may be moved to a different part of the circle, and a very severe test of the division be applied.

As an example of the accuracy with which planing may be done, the building-up of the wheel rims may be noted. The joints between the segments are, of course, planed. These joints will be seen to be of considerable depth, and it is, of course, necessary in such a job that there should be a positive contact the entire depth of the joint. It will be seen that, granting the segments to be all alike, any error in the angle between the ends would be multiplied as the segments are bolted together, the last joint being open by an angle six times the error in each piece. The amount of this opening at one edge would also be in proportion to the depth of the joint, and the difficulty of making a satisfactory joint would obviously increase with the depth of the joint, which is here the considerable figure of 26 inches. We think there are few mechanics who would attempt this job without expecting to do a liberal amount of work with file and scraper before the last joint was made to close satisfactorily. Nevertheless, in this case no hand work was done. The segments were put together as they came from the planer, a joint being made which would satisfy anyone.

Still another illustration of the character of the work was shown on one of the gears. After bolting the segments together, the next operation is boring the inside, and following this comes cutting the teeth. On one of the gears a defective casting was discovered during the boring, and that segment was replaced by another. After reboring the gear with this segment in place, another defective segment was found when cutting the teeth. This second segment was also replaced, the hole again rebored and the cutting of the teeth completed, and the resulting gear fulfilled the requirements perfectly.

shown in Fig. 2, where *A* is a spur wheel, forming an integral part of the sleeve on which the hob is placed; this sleeve running freely upon the stud *B*. Stud *B* is driven into an eccentric, which is fitted to and can be turned within a bearing in the head-stock. To this eccentric is cast the lever *C*, and also an arm carrying the idler *D*. By means of this eccentrically mounted stud the wheel *A* can be made to engage direct with the wheel on the spindle, or may be driven through the medium of the idler *D*, which is then driven by the spindle gear.

At Fig. 3 is shown the arrangement of turret and slides. The turret turns on a hardened and ground stud *a*, to which



UNIVERSAL MONITOR LATHE.

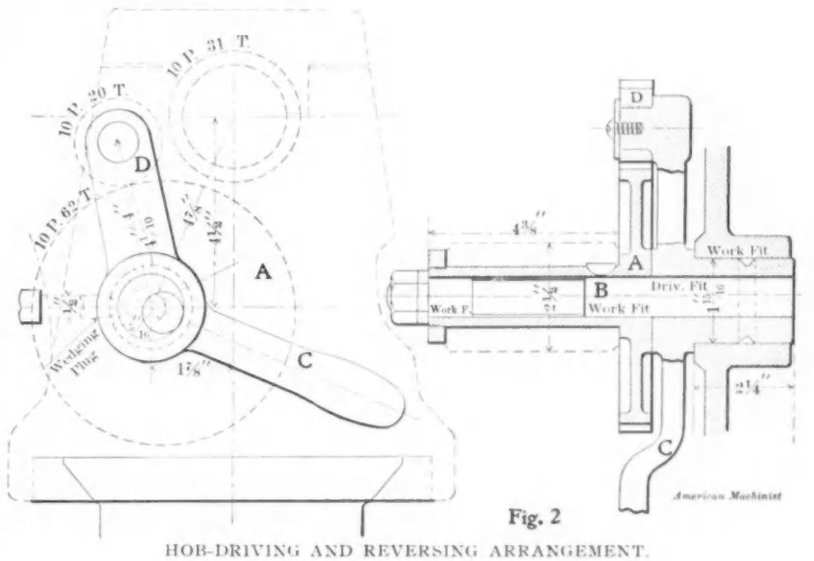


Fig. 2

HOB-DRIVING AND REVERSING ARRANGEMENT.

Universal Monitor Lathe.

Dreses, Mueller & Co., of Cincinnati, O., have recently designed and built a universal monitor lathe, of which we give engravings.

As will be seen, the machine does not depart very radically from the usual construction of such tools, but we give some of the working drawings, which may prove interesting.

The chasing hobs are arranged to be reversed, so that the same hob answers for both right and left hand threads, and this is accomplished by the arrangement

is fitted the adjusting cone seen above. The index ring is of hardened steel, and the index bolt is also hardened and ground. It is withdrawn by the lever seen at the side of the slide.

Plate *b* swivels to give any desired taper, the cross-slide below always remaining square for facing-cuts.

The head-stock of the machine rests upon a taper wedge, by which perfect alignment of live spindle with turret can be maintained, and a friction clutch enables the back-gear to be thrown in and out without stopping.

The Taylor Hydraulic Air Compressor.

In the "Canadian Engineer" for November we find an account of the completed compressor on the above system, now at work at the Magog Print Mills, at Magog, Que., Canada, together with a table of results obtained in an efficiency test by Prof. C. H. McLeod, of McGill University, Montreal. A description of the system will be found in our issue for June 20th of last year.

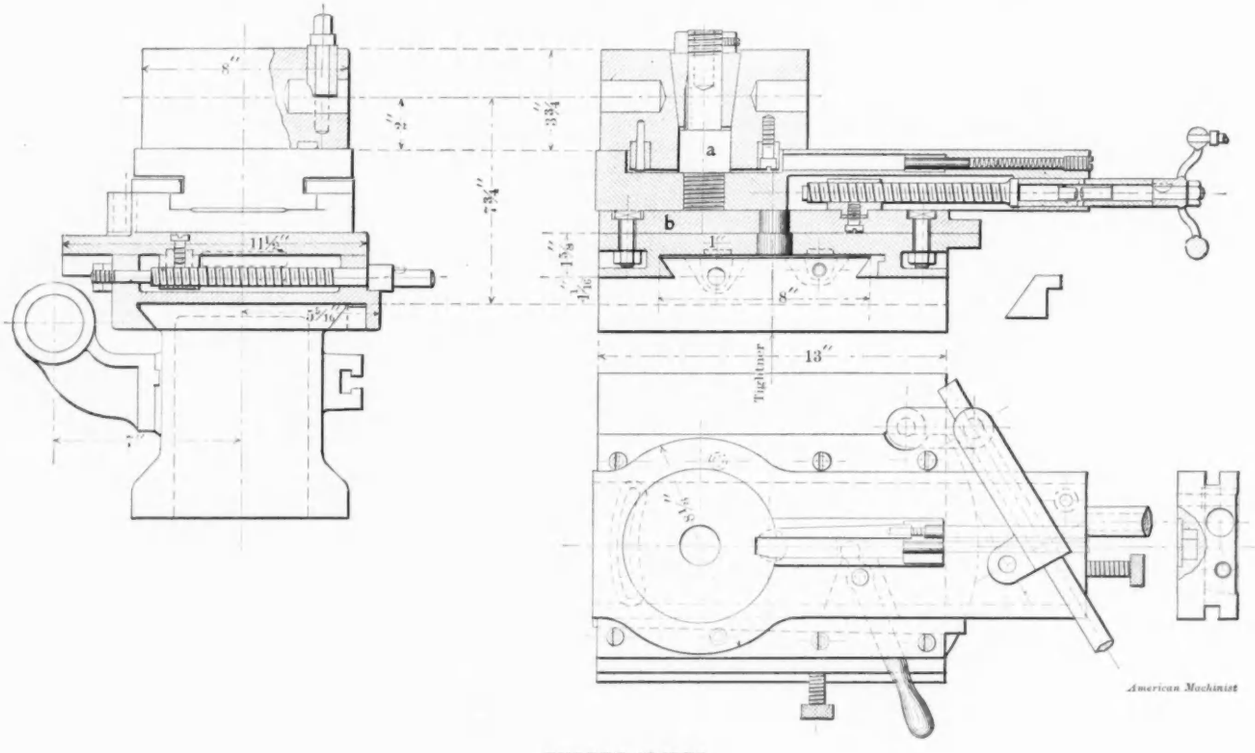
The Magog Print Mill is situated alongside an excellent water power which drives most of its machinery. The printing machines, however, have always been driven by steam in order to obtain control over the speed, which is required to be varied according to the work, and more readily and minutely than could be accomplished with cone pulleys. Each printing machine is provided with its own engine to accomplish this variation of speed, and for some years the authorities of the mill have considered the scheme of driving them by compressed air obtained from the water power. In fact, some four or five years ago they installed a plant of mechanical compressors, which, however, was a failure because of inadequate capacity and poor design.

The present scheme is a very bold as well as original piece of work, as nothing had been previously constructed by the company beyond laboratory models. The present plant involved a heavy expenditure for sinking a shaft in rock to a depth of 120 feet, together with much other expensive construction, and too much praise cannot be accorded for the courage which constructed such a plant on the strength of results of laboratory experiments.

Following is the table of results obtained in Professor McLeod's tests:

RESULTS OF TRIALS OF THE TAYLOR HYDRAULIC AIR COMPRESSOR AT MAGOG, P. Q., ON AUGUST 7 AND 13, 1896.

No. of Trial.	Quantity of Water Discharged in Cubic Feet per Minute.	Available Head in Feet.	Available Horse-power	Quantity of Air Delivered per Minute in Cubic Feet at Atmospheric Pressure.	Pressure of Air in Compressor.	Actual Horse-power of Compressor.	Efficiency of Compressor.	Temperatures. External Air.	Temperatures. Water.	Temperatures. Compressed Air.
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
1	6,122	21.4	247.7	1,377	52	132.5	53.5	79	75.2	75.2
2	5,504	21.9	228.0	1,363	52	131.0	57.5	83	75.5	75.5
3	4,605	22.3	168.9	1,095	52	105.3	62.4	80	75.6	75.5
4	7,662	21.1	305.9	1,616	52	155.4	50.8	75	80.0	80.0
5	6,312	21.7	260.0	1,506	52	144.8	55.7	77	80.0	80.0
6	7,494	21.2	299.8	1,506	52	150.2	50.1	75	80.0	80.0



TURRET SLIDES.

Professor McLeod also states in his report that the operation of the plant has already shown where modifications can be made, which he considers it reasonable to suppose would increase the efficiency by 10 per cent.

It should be pointed out, however, that the figures give the efficiency of the compression only, and do not include the losses due to converting the energy of the compressed air into an available form. These losses are considerable, and with most engines of the usual form, serious.

Considering the entire absence of mechanical transmission between water and air, the efficiency is low, and from any point of view is not high. The ratio between the power required for isothermal and adiabatic compression for the pressure developed is .79, and assuming a further loss of 15 per cent., due to the friction and other losses of a mechanical compressor, would give for the efficiency of such a compressor, computed on the basis of the above table, 68 per cent. Of course, in water-power work efficiency is often, perhaps usually, of secondary importance; and, independent of that, the present system has the great merit of absolute mechanical simplicity. Our impression is that the field to which the system must look for usefulness is in its application to water power of low heads, where the cost of mechanical compressors is excessive. With high falls, to which mechanical compressors lend themselves so readily, it does not seem to us that the Taylor compressor can compete on even terms.

While this is the first commercial application of the system, it is not a new thing in its inception. It is essentially the hydraulic blower of the old Catalan forge, and, in fact, experiments have been on record for several years looking toward the application of the system to the transmission of power. This, however, in no sense detracts from the merit of the enterprise. We shall watch future developments of the system with great interest.

▲ ▲ ▲

The Printing Press in the Drafting Office.

BY W. H. SARGENT.

It is not in its capacity for the rapid duplication of a given copy that the press finds its greatest utility in the drafting office. It is rather to be considered as a useful tool, much the same as the compasses or the dividers.

In any case where printed matter is wanted in any quantity it will be found cheaper and better to patronize the printer; but for the multitudinous demands of a well kept office, in the line of cards, memorandum blanks and labels, the press will be found a useful adjunct.

The greatest use for a press, however, is for lettering plans and drawings. Printing on tracing cloth offers at once the greatest attraction and the greatest difficulty. The ink must dry quickly; as a rule, the tracing is wanted for printing the instant it is done; and no matter how carefully the drawing is handled it is sure to "smooch."

When put into the printing frame, the ink is liable to "offset" onto the glass. Then, again, the ink must be *dense* enough and must retard the light enough to make white lines on a blueprint. Now, the best of inks, such as wood-cut or half-tone blacks, when printed on tracing cloth, are transparent when viewed by transmited light; *i. e.*, when looked *through*, not *at*.

If the ink is run heavy enough to be suitably opaque, it will be found to dry too slowly; in fact, all printing inks dry very slowly on tracing cloth, owing to the peculiar surface of the fabric, which absolutely refuses to absorb the oils of the ink. An ink which would dry overnight on coated book paper might require days or even weeks on tracing cloth, and some inks would never dry so but that they would rub when handled.

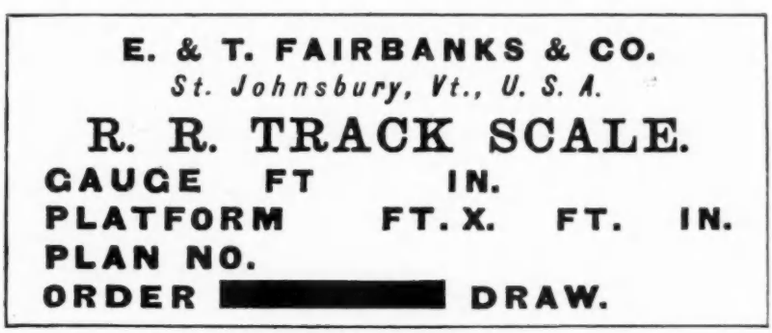
After a large amount of experimenting, the following process has been found satisfactory on tracing cloth: Use a quick-drying, heavy-bodied ink. Indicate by faint pencil lines on the tracing where the lettering is to come. Take an impression on the platen of the press, and place the tracing over it so that the pencil marks correspond and print upon the cloth. Remove the cloth, and dust whiting or powdered chalk upon the printing, on both sides of the cloth. Enough of the powder will cling to the lettering to absorb the oil, and at the same time materially increase the density of the ink.

This process will not, as may be feared, cause the printing to turn white or even gray, but will remain a deep velvety black of good printing density, which may be handled and printed immediately. For marking plans it is, of course, necessary to adhere to a certain uniformity. The labels must be on the same corner of the sheet, or on large plans on the two opposite corners, and should contain the name of the firm, the title of the drawing and such other information as the business demands. The accompanying card is one illustration.

The type may be left standing and the necessary changes made from time to time, or an electrotype can be made for each different label in common use; then there will be no setting up, no errors and no loose type. A self-inking press, about 8 x 12 inches chase, and a dozen fonts of Roman and Gothic type of different sizes would make a convenient outfit.

The observant draftsman will have noticed before that it is no longer customary in printing a label to use every style of type in the office, but rather to confine the composition to a few sizes of the same or similar faces.

St. Johnsbury, Vt.



THE PRINTING PRESS WITH DRAFTING OFFICE.

▲ ▲ ▲

The Best Air Compressor for Shop Service.

BY FRANK RICHARDS.

On the evening of November 19th I had the pleasure of attending a regular monthly meeting of the Railroad Club of New York, at the house of the American Society of Mechanical Engineers. The rooms were crowded with interested members. The subject for the evening's consideration was the general topic of Compressed Air, a very complete paper by Mr. C. W. Shields, which was printed and circulated, forming a basis for the discussion. As the annual election of officers of the club and other business occurred the same evening, an enjoyable collation being also provided, the time devoted to the consideration of the paper was necessarily limited. The principal remarks were offered by Mr. Vreeland, of the Metropolitan Traction Company, N. Y., and Mr. W. L. Saunders, C. E., Secretary and Manager of the Ingersoll-Sergeant Drill Company. Mr. Vreeland's remarks were of great interest, telling as they did of the experience of his company with their invitation to the inventors of the world to offer a suitable motor for street-car traction, and of their experiments and experience thus far in the use of compressed air for the purpose. While the speaker said that a car or cars were making trips satisfactorily, he was absolutely unable to say anything of the economy of operation, or of their all-around efficiency and desirability for permanent and extensive service.

Mr. Saunders gave a general view of the principal features and difficulties encountered in air compression, transmission and application, and then a sketch of the present status and prospects of compressed air for power purposes. Other speakers spoke briefly of the practical use of compressed air in shops for every-day service, and the question arose as to what is the best style of compressor to use for general shop work, and it has occurred to me to note here a few considerations that may in some cases help in determining this matter.

I am moved to remark at the outset, not as a hit at what was contributed at the meeting referred to, but as bearing more or less upon available compressed-air literature as a whole, that one of the worst things in the world is the reckless and injudicious telling of the truth. It makes more trouble in the world than all the lies that were ever invented, and compressed air has suffered much from it.

It is only telling the truth when attention is called to the loss of power in air compression, on account of the heating of the air during compression and its subsequent cooling and contraction. In compressing to the ordinary working pressures, say 75 pounds gage, the difference between the best and the worst possible or actual practice is only about 25 per cent. in power cost. The compression of the air without any special devices for cooling during the compression will not consume more than 25 per cent. more power than will be used for compressing the same volume of air to the same pressure and with the most com-

plete cooling devices that are known. The 25 per cent. is the greatest possible loss, as far as the adiabatic and isothermal business is concerned.

The class of compressors usually under consideration are those which are steam-actuated, or self-contained and complete machines, combining the steam engine and the air-compressing cylinders all in one. With these steam-actuated compressors the possible differences in power cost, or, rather, ultimately, in the fuel cost, of the steam end of the machine are very different in magnitude from those on the air-compressor end of the same machines. Some compressors are built which show a very high steam economy. Builders will furnish compressors of the five C type, the Corliss Cross Compound-Condensing Compressor, and guarantee that the coal consumption shall not exceed two pounds per horse-power hour.

The companies who furnish these compressors find a large part of their business in compressors which show a very different steam economy. Many, if not most in number of the steam-actuated compressors in use have plain slide valves without cut-off, and with not too small clearances, and even with good boilers and piping it is not to be expected that their coal consumption will be less than six pounds of coal per horse-power hour, while with poor boilers, defective or objectionable piping, weather exposure and such unfavorable conditions, it will easily run up to eight or ten pounds. Now, in telling with unceasing reiteration this actual truth about the possible 25 per cent. of power loss in the air cylinder, and in saying so little, or generally nothing, of the 200 or 300 per cent. of excessive fuel expenditure at the steam end, there is something out of proportion. While nothing but the truth is told, only a little of the truth is thus generally told, and it is not to be wondered at that false impressions are conveyed.

The air-compressing cylinders are practically as efficient in the small and cheap compressors as in the larger ones, and in the case of water-jacketed air cylinders the advantage is with the smaller compressing cylinders; and all through it may be said that the cheapness of operation of either directly or indirectly steam-driven air compressors depends upon the steam engine which drives them, whether the steam engine be a part of the machine itself or whether the compressor and engine are separate. If a shop is driven by a good and reasonably economical steam engine, and if the compressor is driven by a belt from the line shaft, it is driven more cheaply than if it was attached to and considered a part of a small and wasteful direct-acting steam engine.

All considerations seem to indicate that for general shop use the belt-driven air compressor is in every way preferable to the steam-actuated machine. It is to be understood that I nowhere refer to the air-brake pump, but to the regular steam-actuated compressor of any of the well-known makers. The first cost of the belt-driven air compressor is considerably less than that of the steam machine; the cost of driving it is considerably less for the same amount of work, because it is driven by a more economical steam engine; and, what is quite important, there is more than one belt machine on the market which is completely and reliably automatic, maintaining the required pressure, and stopping and starting itself without any looking after, and costing nothing for power except when actually compressing and delivering air—all of which can scarcely be said of any of the steam machines within my knowledge.

At the meeting above referred to one of the speakers spoke of the gas-engine-driven air compressor as the one which he would select for shop use, giving, as the only reason for his choice, the low fuel cost for operating that type of engine. The low cost of operating the gas engine is now sufficiently well known, as also is the fact that this economy belongs to the smaller sizes as well as to the larger ones, which is very different from the way steam-engine economy runs. The fatal objection to the gas engine for this service, however, is in the fact that it cannot be run intermittently, and that it has never been made to automatically stop and start itself, as required for air-compressing, and presumably cannot be so made; so that instead of being the best, it is perhaps one of the worst of air compressors for general use, notwithstanding its economical use of fuel.

In connection with the shop use of compressed air, we should not be misled by the tales that are told, all true though they are, of the economy of reheating the air before using in the motor, hoist, or wherever else it may be desirable to employ it. While theoretically there is a great saving in fuel cost by reheating the air before using, and an actual practical saving also under suitable conditions, those conditions very seldom occur. The air is generally used intermittently, and often in places where the reheater must necessarily be some distance from it; while to get any saving from the employment of the reheater, it is imperative that the air shall be used continuously and with the heater close to the motor. The air should also be used in considerable volume to make the reheating pay. I am more than ever convinced of the practical correctness of my position, as stated elsewhere, that "in the United States at the present time there is probably not one case in a thousand where compressed air is employed and where one cent of profit could be realized from reheating the air."

Mr. Shield's paper referred to the great benefit realized from the reheating in the Hardie street-car motor. This is telling the straight truth again, of course; but the example is absolutely without bearing upon the general use of compressed air, where driving small scattered motors, hoists, drills and other miscellaneous service of the shop. The air in the Hardie motor is charged to a pressure of 2,000 pounds, and generally goes to the motor at a pressure of 100 pounds; the motor is practically running continuously; the heater is close to the motor, and the saving effected is, after all, attributed more to the steam taken up by the air in passing through the hot water than to the heating and expansion of the air alone. When the conditions of the Hardie practice are elsewhere realized, then, of course, a corresponding result may be expected.

▲ ▲ ▲

Engineers for the Navy.

"We see that a committee of presidents of land grant colleges have agreed upon a plan for enlarging the supply of naval engineers. The gentlemen in question are Dr. Atherton, of the Pennsylvania State College; Dr. Smart, of Purdue University, Indiana, and Dr. H. C. White, of the Georgia State College of Mechanic Arts. They have, we understand, been making a careful examination of the needs of the naval service for almost, if not quite, a year past, and are now, they think, in a position to say just what those needs are. They report that they are prepared not only to recruit the Engineer Corps of the Navy, but to provide a naval engineering reserve upon which the Government can confidently call in case of an emergency.

"It is not within our knowledge that the President or the Secretary of the Navy has complained of any difficulty in finding engineers enough for the service. Nor have we heard of any European nation—even England or France, either of which nations employs five or six times as many naval engineers as the United States does—that has had to resort to extraordinary means in supplying itself. There may be a scarcity of material, but so far the head of the department has not complained. We prefer to assume, therefore, that the gentlemen above referred to have been superfluously anxious concerning the service.

"In our opinion, the Secretary of the Navy, speaking for the President of the United States, is the only authority in these matters. The Government has its own college for the training of naval officers. The persons in charge of that college know far better than the heads of any civilian schools can possibly know what the service needs, and how best to meet those needs as they arise. We are aware that a bill has been introduced in Congress looking to some such result as is contemplated in the scheme of the National Association of Land Grant College Presidents. We are aware, also, of the fact that this matter has been, under vari-

ous forms and influences, agitated for some years past. But we are free to say that none of the propositions growing out of this agitation has commended itself to our approval. The Government should by all means be left to train those who are to serve it—especially in places of great responsibility—left to train them in such fashion as it may select. The Government is the best judge of its own needs, is quite able to supply them, and will be much better off in every way if permitted to attend to its duties without external assistance and advice.

"After all, there can be no approach to absolute efficiency in any kind of military organization without perfect discipline, and that discipline is not easy of achievement unless it begins at the beginning."

The above is an editorial article printed in "The Post," of Washington, on the 14th inst. It was inspired by line influence if not written by a line officer, and, as will be seen, resents with lofty scorn any suggestions from outside sources. The Secretary of the Navy and the line officers are declared to be abundantly competent to manage naval affairs, and the fact that numerous reports of Chief Engineers, and some also of Secretaries of the Navy, have declared the supply of engineers to be deficient, is entirely ignored.

The article translated in plain words means that the "line clique" considers itself competent to manage the Secreary and all else pertaining to the Navy, and that any expression of opinion or suggestion from college presidents or other common citizens is considered an impertinence.

▲ ▲ ▲

The ancient restrictions against traction engines in England have been removed so far as they apply to "light locomotives," which means horseless carriages. If the carriage, unladen and without fuel and water, weighs less than one ton and a half, a speed of twelve miles per hour is permitted. If weighing between one ton and a half and two tons the maximum speed is to be eight miles per hour, and above two tons the speed is limited to five miles per hour. At speeds below those named, the public has no protection beyond a warning bell, and must keep out of the way.

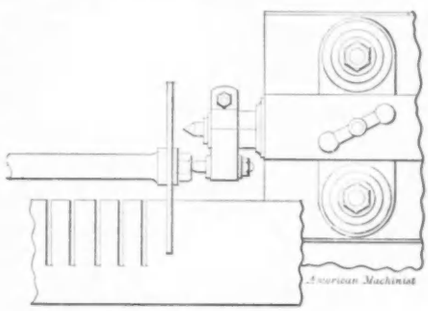
▲ ▲ ▲

The Cincinnati, Hamilton & Dayton Railroad has acquired the street railroad lines of Middletown, O., and will connect the tracks with its steam line, and run through electric cars from Middletown to Hamilton. Later, the electric system will be extended to the road's Cincinnati suburban traffic, which is the heaviest of any line entering that city. The equipment will be of the most modern and frequent trips and low fares will be adopted.

Lathe Tail-Stocks—The Tail-Spindle Turret.

BY TECUMSEH SWIFT.

It would really seem that a wider field of usefulness might be and should be accorded the lathe tail-stock than it is usually permitted to occupy. It is probably not worth while to look very far as to who is to blame for the neglected possibilities of the tail-stock, but it probably lies with the tool-builders rather than anywhere else. The lathe-builders do not seem to assume that the tail spindle is ever to be used for anything but to carry the tail center, and to support one end of any work that is to be turned on the centers. This is, without doubt, the primal function of the tail-stock, but there are for it other very different and still very important uses. There is the feeding of chucking drills, for instance. In this service the thrusting of the drill forward is all that is usually required of the tail spindle, while the torsion of the drill is taken by a slotted drill-holder in the tool-post. That



THE OFFSET CENTER.

practice is all right in many cases, while in many others the drill-holder in the tool-post is decidedly in the way, and is a hindrance rather than a help if it could only be dispensed with. For chuck work, if the tail spindle were provided with an automatic feed, its value and usefulness would be greatly increased. Some larger lathes are equipped with the tail-stock feed, but its use might be greatly extended, and especially for all lathes that are likely to be much used for chuck work.

You talk to builders about these things, and they tell you that there is no demand for them. There is not much demand for anything. We don't know what we want, half the time, until we see it, and not always then. When there is anything good offered in the line of machine tools, some will catch on after a while, and to the first who appropriate it, it becomes an effective offensive weapon of trade warfare, and then the others begin to cry for it, to use it in self-defense and to save their trade from being taken away by the cheaper producers.

But while there may be some legitimate question as to the general necessity for the automatic feed for the tail spindle, there can be none as to a better provision for resisting torsion. The modern lathe has a round spindle with the nut and screw in the middle of it, and the spindle is held from turning by a spline along the under side of it, and a little and short feather concealed in the barrel of the tail-stock. More than one of these absurd little feathers I have worn entirely off, and have had to renew in the general run of everyday lathe work, and without subjecting the spindle to any exceptional torsive duty. The edge of this little short feather also often crushes the edge of the spline in the spindle and raises the metal so that the spindle will begin to bind in the barrel, and then it becomes necessary to take it out and file the burr off.

It is not necessary for me to offer any suggestions as to the proper means of securing the tail spindle from turning. There are many effective ways of doing it. The spindle might be made a little larger in diameter, with a considerably larger spline and a feather of sufficient length to reduce the wearing, or at least the edge-crushing operation, within reasonable limits. The feather might also be placed at the side, or even on the top, rather than at the bottom, where it is impossible to oil it.

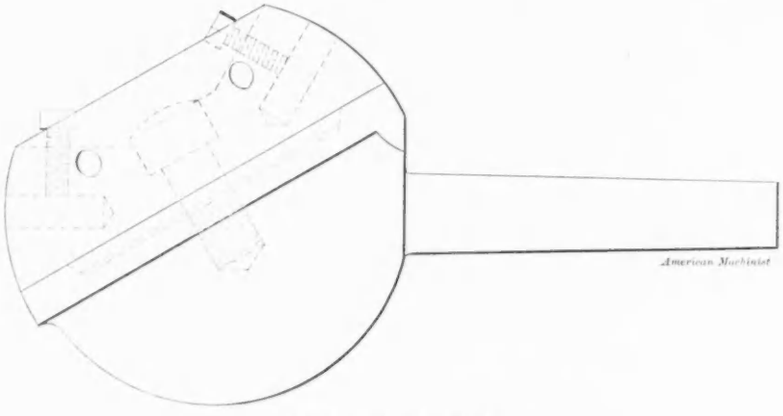
The modern lathe is usually decidedly inferior to those of earlier date in the means of holding the tail spindle. Many of those old lathes had square tail spindles, and in still older ones the actuating screw was not in the center of the spindle, as now so common, but usually at some distance below it, with a guide below that; the spindle, screw and guide all being connected by a vertical arm. I remember a 20-inch lathe, or about that size, far from new when I knew it, built by Gay & Silver, North Chelmsford, Mass., shortly before the Putnam lathe began its revolutionary mission in teaching so much about how to build lathes. The Putnam lathe stirred up the old ideas something as the Corliss engine did. Well, this Gay & Silver lathe had many good points and it had a square tail spindle, and this spindle often enabled us to do things that we could not think of doing on any lathe of similar size in any shop that I know to-day.

I remember that once we had a lot of wrought-iron plates about 5½ x ½ x 48 inches, and we had to saw slits in one edge of these plates, about 3½ inches deep and 1¼ inches apart, the whole length of the plate. These plates were used for spacing the upright saws in the saw gates, that were then used for sawing up the large logs of those days into boards. We used to slit these plates on that lathe with the square tail spindle. We had to make our own saws or cutters, of course, forge, turn all over, file the teeth, temper and do the whole business. The saw was mounted on the end of an arbor or spindle long enough to clear the whole length of the plate to be notched, and this arbor was mounted on the centers and driven by a dog on the end of it. The square of the tail spindle stood diagonally, or with the diagonals

vertical and horizontal. Of course, it would not do to run the arbor on the regular center, for the edge of the plate would not clear the body of the tail stock; so a heavy square collar was forged that would just slip over the square of the spindle and fasten tight with a clamping bolt at the back. (See sketch herewith.) This collar had a boss on the front side, and this was bored and a center fitted to it. This gave us a center with an offset of 2 inches, and the tail-stock was slid over backwards 2 inches, which brought the center in line again; the edge of the plate would clear the body of the tail-stock, and the square spindle would stand the pry of the cut without winking. There is no common shop of to-day that could do that job in a cheap and rough-and-ready way any better than I saw it done, and helped to do it, say, forty years ago, and the square tail spindle had the most responsible part of the whole job.

I have been led to do a little thinking in the direction indicated above by seeing the tail-spindle turret that I give a little sketch of. Of course, the idea of this turret is so far from being new that the same thing may be found in the catalogs of the supply houses, and is a standard article of manufacture; and at the same time it is so far from being generally known that I recently found a home-made specimen of it in a shop into which I strayed, and although home-made, I can testify that it was excellently made and a fine specimen of individual workmanship. This tool has a taper shank to fit the hole in the tail spindle. The angle of the face upon which the turret turns is about 30 degrees to the axis of the taper shank, but the precise angle is of no importance. There are six holes in the turret for the shanks of drills, taps, reamers or similar tools. A spring catch at the back holds the turret in each position; and as all was completed in the home-made turret of which I speak before the holes for the shanks were drilled, their alignment and concentricity were assured. The body of the main piece below the disk upon which the turret is fitted, is quite thick, and its extension below the center line serves to balance the entire tool so that it may also be used in the live spindle if it ever becomes desirable to do so. It is, of course, impossible to balance it perfectly in use, as some tools will weigh more than others, and the change from one tool to another will also change the balance.

In connection with this turret tool, a stop for the tail spindle was also provided. This consisted of a split collar clamped upon the spindle, with a lug upon it extending high enough to carry a long horizontal screw, extending back over the top of the tail-stock. This screw, somewhat longer than the available travel of the tail spindle, moves freely through a hole in a stud that has been screwed fast into the top of the tail-stock casting. Then two adjustable nuts upon the screw act as stops against this stud, although only the stop for the outward movement of the spindle is usually required. If different tools in use at the same time require stoppage at different points, the nut is set for the one that goes farthest, and U-collars of different thicknesses are dropped over the screw for the other tools.



TAIL-SPINDLE TURRET.

▲ ▲ ▲

Formulae for Ball Bearings.

BY H. ROLFE.

I have seen Mr. Babbitt's letter on the above subject, and may perhaps be allowed to offer some supplementary remarks thereon, taking into account the matter of clearance between the balls.

I suppose there always is a certain amount of initial play allowed in a nest of balls, not so much (as some may, perhaps, think) for the sake of maintaining a film of oil between them, as to insure their going into the race at all, when assembling. These balls are very nicely got up, their manufacture being, I believe, in the hands of one or two people who make a feature of them, supplying them, I think, to all large bicycle makers, etc., and may generally be relied on to half-a-thousandth of an inch. But if half of a nest of 30 balls were each that amount in excess (and you do not pick and choose when assembling), it would be fatal to all chances of their forming a happy family; as much so as if there were an extra ball among them Also, the races shrink a trifle in hardening. Besides, even granted balls of accurate size, it is an unmechanical job putting in a lot that "just go in."

I had occasion to look into this question twelve months ago, and drew up the subjoined formulæ for future use; then I was dealing with ¼ to ⅜ balls. The amount of play allowed was about 1-16 inch in a nest of 20 balls, say. I have since then put in 1¼-inch balls; 30 tons load on one nest; allowed from 12 to 15 thousandths between each ball. By the way, as to actual conditions of running, whether the balls all crowd on one another, leaving most of the play between one pair, or whether they considerately maintain equal distances apart, I can't say; don't know that we need worry about it, either. The above amount of play gives about .003 inch between each pair, and is about right, I should say. It is *the* important point, and, I wish to add, is not due to me at all; I take no credit for it. I started with that much given; the result, I believe, of large experience with ball bearings on the part of other people.

However, my object was not to say much about the practical side of the question. I dare say plenty of your readers have had more opportunities of gleaning information on that score than I have had.

In the annexed Fig. 1 (in which the clearance is exaggerated for sake of clearness), join *a*, *b*, the centers of two adjacent balls, and draw the normal *o c;* then *o c a* is a right angle, and *d c* = the semi-clearance between the two balls.

If S = the total circumferential play in the ball race, and n = the number of balls, then $\frac{S}{n}$ = play between two balls = s.

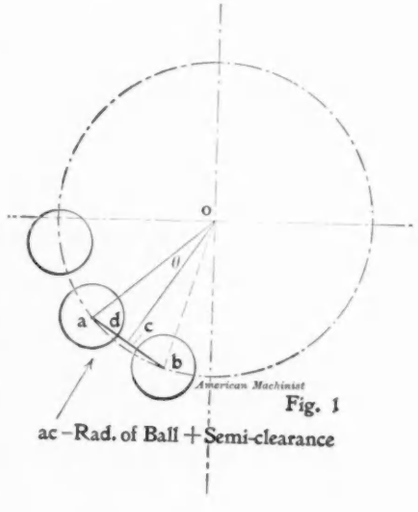


Fig. 1

We have four quantities involved:

D = diameter of ball circle;

d = diameter of balls;

n = number of balls;
s = clearance or space between any two balls.

$d\,c = \frac{s}{2}$ in the figure: also

$$\theta = \frac{360^\circ}{2\,n} = \frac{180^\circ}{n}$$

Now, in Fig. 1, $o\,a = a\,c$ cosec. θ; that is,

$$\frac{D}{2} = \left(\frac{d}{2} + \frac{s}{2}\right) \text{cosec. } \frac{180^\circ}{n} \text{ or}$$

$$D = (d + s) \text{ cosec. } \frac{180^\circ}{n} \qquad \text{(A)}$$

By transposition we can get any one quantity, given the other three:

(1) Given number and diameter of balls and the clearance; to find diameter of ball circle, use the expression just obtained (A).

By the way, with a book of Tables at hand, this form is best, as nine people out of ten would rather multiply decimals than divide. As pocket books, however, as a rule, don't give the cosecant, but only its reciprocal, the sine, we may as well write it thus:

$$D = \frac{(d + s)}{sin. \frac{180^\circ}{n}}$$

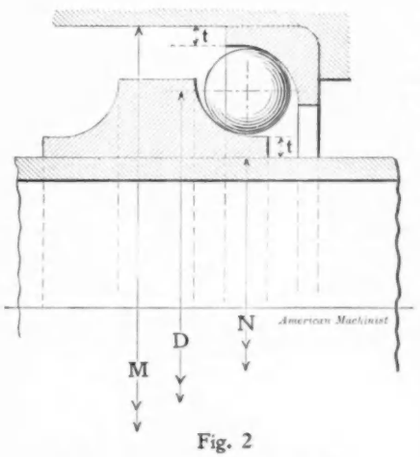


Fig. 2

LAYING OUT BALL BEARINGS.

(2) Given diameter of ball circle, number of balls and the clearance; to find the diameter of balls:

$$d = D\ sin. \frac{180^\circ}{n} - s.$$

(3) Given diameter of ball circle, diameter and number of balls; to find the clearance:

$$s = D\ sin. \frac{180^\circ}{n} - d$$

(4) Given diameter of ball circle, diameter of balls and the clearance; to find the number: First find sin. $\frac{180^\circ}{n}$ from its general value $\frac{d + s}{D}$. Then find from the Tables the corresponding angle; equals x degrees, say. Then $\frac{180}{n} = x$; whence $n = \frac{180}{x}$.

In actual designing it will be found convenient to have all these four formulæ at hand, as may perhaps be seen by dealing with an imaginary case. See Fig. 2, which is part of a bearing: Say at first drafting, we have M of such a size that, allowing suitable thickness for ball races, we find D requires to be about 1½ inches; we desire to put in ¼-inch balls and give about .003 inch clearance. How many can we get in?

By (4), sin. $\frac{180^\circ}{n} = \frac{d + s}{D} = \frac{.253}{1.37} = .1847$, whence $\frac{180}{n} = 10^\circ\ 39'$ about; say 10.65 deg., and $n = \frac{180}{10.65} = 16.9$; that is, we get 16,9 balls as the number required.

Now, if we put in 17 balls, we shall have too little clearance; and if only 16, decidedly too much. From (3) we can find the actual amounts, and so see which arrangement, if either, is permissible.

If neither, then use (1) and find what diameter the ball circle must be to take 17 balls, same conditions as before. To get this new diameter, we must either increase M or diminish thickness t of outer race. Suppose, for sake of argument, we cannot afford to do either; then we could put in 16 balls and decrease N, keeping M as before, and increasing t for both races; or if t were quite sufficient, and metal outside M were already rather scant, we could lessen M by same amount as N, keeping both ball races the same as before.

If, for the sake of illustration, we suppose the balls were to be made for the particular job in hand, and of any size required, however odd, then apply (2) right away, and see what size of ball would do, using 17 of them on a 1½-inch circle, with .003 inch space between each.

This expression (2) might often come in useful. For instance, A is checking B's drawing and sees 20 balls put on a 2.02-inch circle; he knows the clearance is supposed to be about .003 inch and wishes to ascertain if the conditions *do* allow of a market size of ball: Using (2), he finds the ball should be .313 inch diameter, nearly; that is, $\frac{1}{320}$ inch more than $\frac{5}{16}$ inch, so he lets it go at that (namely $\frac{5}{16}$ inch).

Where likely to be much used, a table could be made from these formulæ, giving at a glance any combination of the four quantities.

▲ ▲ ▲

Mr. Geo. W. G. Ferris, who is popularly credited with the invention and design of the great wheel at Chicago, died in Pittsburg on the 22d ult. Mr. Ferris was a graduate of Rensselaer Polytechnic Institute, New York, and had been in practice as a civil engineer for some time, but his ability was rather as a promoter than as a skilled engineer. He will be best known by his work in connection with the wheel which bears his name, and which, we understand, proved a profitable venture for him.

Diagram of Proportions of Elliptical Arms.

In our issue of September 24th, Mr. Freeland gave us a diagram showing the power transmitted by belting, from the reference book of Mr. S. E. Freeman, of the Todd & Stanley Mill Furnishing Company, St. Louis, Mo. We are permitted now to present from the same source another diagram which will also be found useful. It is for determining the dimensions of elliptical arms for belt or rope pulleys, or similar wheels used for power transmission.

The diagram, it will be seen, simply gives the width and thickness of elliptical arms, both at the center of the wheel, supposing the arm to be continued to the center, and also the dimensions at the circumference of the wheel, for pulleys of different diameters and different numbers of arms, and for single belt, double belt, or for rope driving, with a given number of ropes of diameter also given. None of these particulars are applied directly to the table, but, instead of that, the factors, as grouped under the cube root sign in the formulas, in the upper left-hand corner, for the different styles of wheels, are combined into a whole number, and this number is used to locate the given case upon the base line of the diagram. The diagram is reproduced full size, so that it may be used by actual measurement of it as well as by reading the figures indicated.

Now, for example, say that we want a single-belt pulley 48 inches diameter for 12-inch belt, and with five arms: The factors under the cube root sign are $\frac{D\ W}{4\ a}$, and substituting our values we have $\frac{48 \times 12}{4 \times 5} = 29$. Then finding the location of 29 on the base line and running up vertically, we have simply to note the height at which the several oblique lines are intercepted to read off the dimensions required. The width of the arm at the center of the pulley h will be $3\frac{5}{16}$ inches, and at the circumference h^1 it will be 2¼ inches. The thickness of the arm at the center of the pulley b will be $1\frac{5}{16}$ inches, and at the circumference b^1 it will be ⅞ inch.

If we want a double-belt pulley 60 inches diameter for 18-inch belt, and with six arms, the number under the cube root sign will be $\frac{3 \times 60 \times 18}{8 \times 6} = 68$, and the dimensions of the arms will then be: Width of arm, 4 5-16 and 2⅞ inches; and thickness of arm, 1¾ and 1⅛ inches.

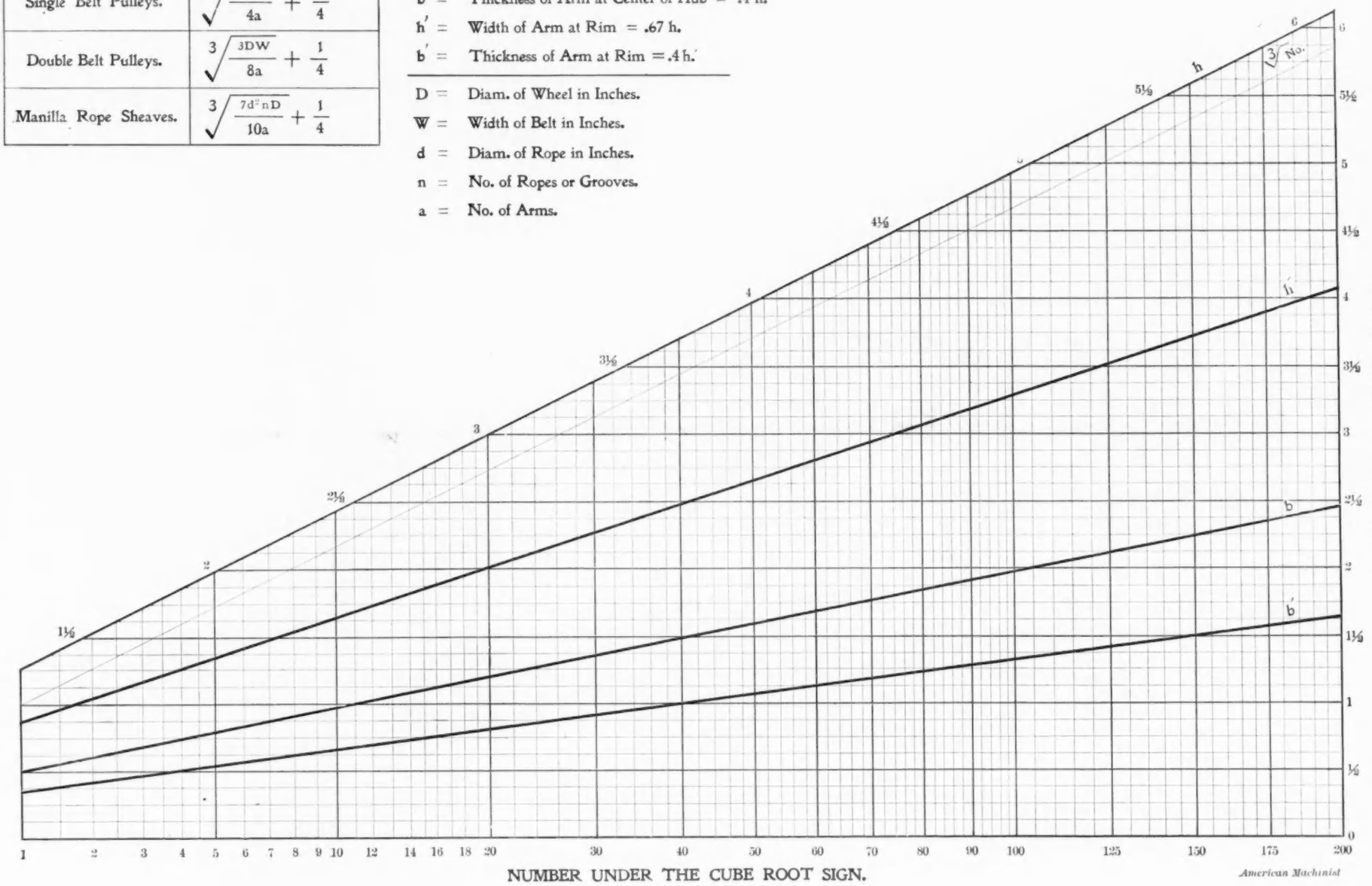
For a rope sheave 8 feet diameter for 8 ropes 1¼ inches diameter, and with six arms, we would have $\frac{7 \times 1.25^2 \times 8 \times 96}{10 \times 6}$ = 140, and then the arms would be $5\frac{7}{16} \times 2\frac{3}{16}$ at the center of the pulley, and $3\frac{5}{8} \times 1\frac{7}{16}$ inches at the circumference.

PROPORTIONS OF ARMS OF WHEELS. — ELLIPTICAL SECTION.

KIND OF WHEEL.	FORMULA FOR h
Single Belt Pulleys.	$\sqrt[3]{\frac{DW}{4a}} + \frac{1}{4}''$
Double Belt Pulleys.	$\sqrt[3]{\frac{3DW}{8a}} + \frac{1}{4}$
Manilla Rope Sheaves.	$\sqrt[3]{\frac{7d^2nD}{10a}} + \frac{1}{4}$

h = Width of Arm at Center of Hub.
b = Thickness of Arm at Center of Hub = .4 h.
h′ = Width of Arm at Rim = .67 h.
b′ = Thickness of Arm at Rim = .4 h.

D = Diam. of Wheel in Inches.
W = Width of Belt in Inches.
d = Diam. of Rope in Inches.
n = No. of Ropes or Grooves.
a = No. of Arms.



The Mossberg End-Thrust Roller Bearing.

I send you photographs and sketch showing the construction of our roller end-thrust bearing, hoping that it may interest some of your readers. Like lots of other good things we have in the mechanical world, it is an illustration of the law of evolution, or of "the survival of the fittest."

Having an end bearing on one of our wire-draw benches which gave us a great deal of trouble, the first attempt to improve it was by the use of a nest of steel balls set in a hardened cup. This gave us good results at first, but would wear grooves in the thrust collar of the shaft, and our next trial was to put in a spiral row of holes in the cup, and then put the balls in these. This worked all right on a light pressure, but the balls would crack and split under a heavy strain. Finally our vice-president, Mr. Frank Mossberg, devised and put into use the roller bearing, as shown in cut, and it has never gone back on us under any circumstances. It is a modification of our regular roller bearing, adapted to be used as an end-thrust bearing. The rollers, which are conical, and the axial lines of which all meet in a common center, are of tool steel hardened and ground and set in a holder, or, as we call it, a cage, so that the bearing is self-contained, and the rollers cannot get out of place and will not fall all to pieces, like a Chinese puzzle, if you should drop it on the floor. We have tried it in all sorts of places, from a ½-inch shaft up to bearings for water-wheels and propeller shafts; one now being in use on the steam yacht "Halcyon," owned by Mr. Howard C. Smith, of New York, which has given good results, both as regards speed and economy, and we have several more to put in this coming winter.

The second cut shows a test made of this bearing to determine the amount of power required to revolve it under a given weight. We placed the bearing out in the casting yard, piled on all the drop-press bases we could get hold of and balanced them on the same When so weighted, the application of a 20-pound weight attached to the extreme corner of the lower base would start the whole lot. The combined weight of the pile was about 8,000 pounds.

J. L. LUCAS,
With Mossberg & Granville Mfg. Co., Providence, R. I.

[Mr. Lucas omits to state the size of the bearing and the radius of the point of attachment. From Fig. 1 we judge the bearing is 12 inches diameter. Assuming that the radius of the point of attachment is 12 inches, which probably is not far wrong, we have a co-efficient of friction of .005 for the arrangement. The arrangement includes, however, the small sheave pulley at the left, over which the cord runs, and the co-efficient for the bearing tested would therefore be somewhat less, though we have assumed the load to be concentrated at the outer edge of the bearing, which is perhaps permissible so long as we guess at the radius of attachment of the cord.—Ed.]

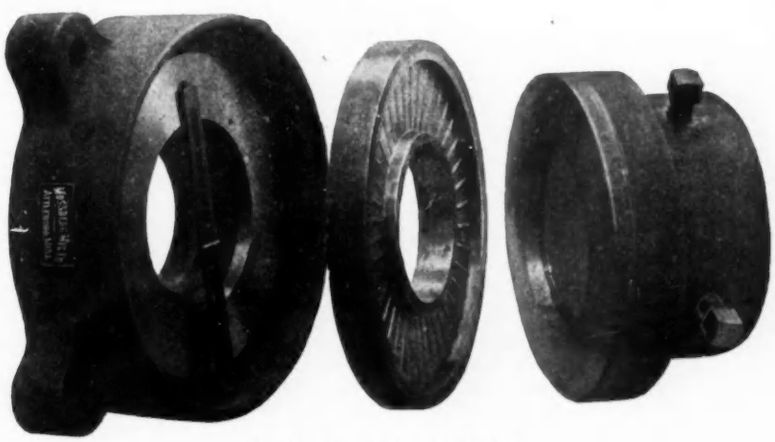
▲ ▲ ▲

TEST OF A ROLLER THRUST BEARING.

A Variable-Speed Countershaft.

The mechanical world appreciates fully the desirability of a variable-speed device for driving machinery. Not only the various tools of the machine shop, but moving machines almost universally, can be worked to better advantage and with greater profit if there is absolute command of the rate of speed at which they are driven. The device illustrated herewith enables the operator to change the speed of his machine by minute gradations and through a wide range. It is claimed that all the range of speeds usually obtained on a lathe by the use of the stepped "cone" pulleys may be secured in this countershaft.

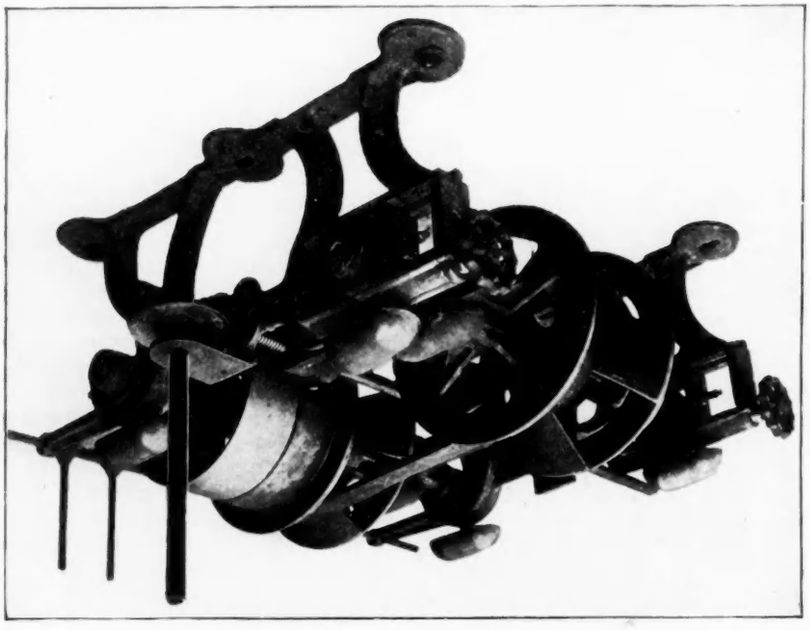
The reader will have little difficulty in understanding the operation of the device from the accompanying half-tone. The countershaft frame carries two parallel shafts, one of which, as shown, has the usual tight and loose pulleys by which it may be stopped or started. The other and nearer shaft has upon it a pulley which carries a belt running down to the machine to be driven. This pulley is hidden, in the view presented, by the large conical pulley which constitutes a part of the speed-changing device. Upon each shaft is a pair of interlocking steep-angled conical pulleys with the larger end of each cone facing outward. A belt, which is practically triangular in section, without the apex of the triangle, runs in the angles formed by the intersection of the interlocking cone pulleys, and serves as the driver from one to the other. One cone pulley on each shaft is fixed to the shaft, while the other slides in and out and makes the diameter at the angle where the belt bears larger or smaller accordingly. These sliding cone pulleys, or half pulleys, while they slide in the same direction, are opposite each other,



ROLLER THRUST BEARING.

Another voting-machine tried at the recent election was the Abbott. It was tested at Hudson, Mich., and the testimony of the Detroit "Free Press" is that it did its work accurately and speedily. Voting is bound to be done by machinery.

so that the effect is to enlarge the diameter of the belt bearing on one shaft and to make it smaller on the other shaft at the same time, or vice versa. The cone next to the tight and loose pulleys is the fixed cone on that shaft, and the other



A VARIABLE SPEED COUNTERSHAFT.

cone on the same shaft slides in and out. On the other shaft the cone nearest the spectator is the sliding cone, and the other is the fixed cone, and the pulley which drives down to the machine is beyond that. As one V-bearing for the belt increases as the other decreases, the belt retains nearly the same tension, while means are provided for moving the driving shaft laterally at any time sufficient to adjust the belt tension. The belt, it will be seen, does not bear upon a continuous pulley surface upon either edge of it, for wherever one edge is bearing, the opposite edge meets only the vacant space of the opposite pulley. These alternate spaces and segments of metal enable the pulleys to slide in and out, and thus accomplish the purpose for which the countershaft is intended. The stem, or broken-off pipe, projecting downward is provided with a hand-wheel or crank at a suitable hight for the hand, and upon turning it the bevel gears above revolve the screw which slides the cones.

We are informed that this device has been tried sufficiently to give assurance of its complete success. The triangular belt will, of course, need renewing occasionally, but it has in several instances given a year's continuous service. It must give a very positive drive, as there is absolutely no slipping of it while in contact with the pulleys, except such as may occur to any belt from overcrowding.

The countershaft, or "speed pulley," is made by the McIntyre Speed Pulley Company, Station D, Pittsburg, Pa.

ELECTRICAL MACHINERY.

The Jungfrau Mountain Electric Railway.

An important undertaking is now under way in Switzerland, which, when completed, is to be an electric railway to the summit of the Jungfrau mountain peak. The line is to start at Scheidegg, and is have a total length of 7½ miles. The total rise is to be 7,000 feet, giving an average grade of over 930 feet to the mile. Six and one-quarter miles of the road are to be in tunnel. The line is, of course, to be for tourist travel, a fact which has greatly increased the engineering difficulties, since not only has the line to be located so as to reach the most attractive points for tourists, but also to avoid, so far as possible, detracting from the natural beauty of the landscape. In carrying out this latter requirement, much of the line will be in tunnel, which might otherwise, and, of course, more cheaply, be built in the open.

Several outlooks of great beauty will be reached by the line, which have heretofore been but little visited by tourists, on account of the difficulty of access. The upper terminus is to be underground to a depth of 330 feet, access to daylight and the summit being reached by an elevator.

The gage is to be one meter, and the maximum speed will be a little over five miles per hour, the total time required for a trip being one hour and forty minutes.

The tunnels being on a grade, it is anticipated that natural draft through them will cause an active circulation; in fact, this is expected to be so active that the portal doors will probably be kept closed to check it. The temperature on most of the line is below freezing, and the warm moist air from the lower levels is expected, if not checked, to deposit moisture on the walls of the tunnels and there freeze.

The necessary electric current for operating the line will be obtained from water power, in which the Alps abound. Two power plants are to be erected, having, combined, 1,400 horse-power. The total cost of the undertaking is estimated to be two millions of dollars.

Some hesitation was felt at first over the effects which might be produced on the passengers due to the comparatively abrupt change from a high to a low barometic pressure. Aeronauts report, however, that no evil effects are to be anticipated. The feeling of exhaustion due to climbing to great heights is absent in balloon ascensions, and is attributed to the exertion necessary when going afoot.

The first section of the line is expected to be opened for traffic next August, and the entire line is to be completed in five years. The fare for the round trip is not to exceed nine dollars.

Making Armature Disks.

The needs of the trade in connection with the great range of sizes and the widely varying demand for different sizes, have developed several distinct methods of making the disks or "punchings" from which laminated armatures are built up. It is only recently that this subject has been of any considerable importance, and an outline of the various methods possesses at present considerable interest. We consequently illustrate several modern machines especially designed or adapted to this work, for the originals of which illustrations we are indebted to the courtesy of the E. W. Bliss Company.

For machines which are made in large quantities the punchings are made complete, notches and all, at a single operation in a suitable press, shown in Fig. 1, of which the point of chief interest is the method of operating the throw-out pads which remove the finished punchings and the scrap from the dies. These, for this class of punching, are elaborate and expensively built-up affairs. Of them we have no drawing to offer; but so far as the arrangement of the knock-out pads is concerned, they do not differ from dies for punching disks without notches. Such a pair of dies is shown in section in Fig. 2, with the throw-out pads *a b c* in place. It is obvious that after the completion of the cutting stroke the inner and outer scrap will adhere to the upper die, while

the ring will remain within the lower die, and the throw-out pads for the different pieces must be located to correspond, as it will be seen they are.

For small work it has been customary to operate these pads by springs behind them. These springs are compressed during the cutting stroke, and as the dies are withdrawn they cause the pads to follow up the dies and push out the pieces. With heavy work, however, and especially in punching the disks complete with the notches, where the notches add very largely to the total profile of the cut, this method is objectionable. The force required to remove the pieces becomes very heavy, requiring powerful springs, which are objectionable, not only of themselves, but because they add seriously to the strains on the press. These springs must be compressed during the cutting stroke, and the force to do this is exerted during the time when the press is already under the strain of the cut. In work of this kind, therefore, positive knock-outs are used, which dispense with the springs and are operated by the press during the upward stroke, when it has nothing else to do. The pins for operating these pads will be seen at *d e f*—several being, of course, spaced around the circle, and cap screws *g h i*, similarly spaced, being adjusted at the limit of the motion and serving to keep the pads in position. The lower pad is operated through the pins by the cross-bar seen in Fig. 1 below the press, this bar being raised by the vertical rods, of which one will be seen inside and next to the frame, which rods are operated by cams on the main shaft. The pins for the upper pads are operated by abutting against a plate carried by adjustable cross-pieces, of which one is shown across the front side of the press frame.

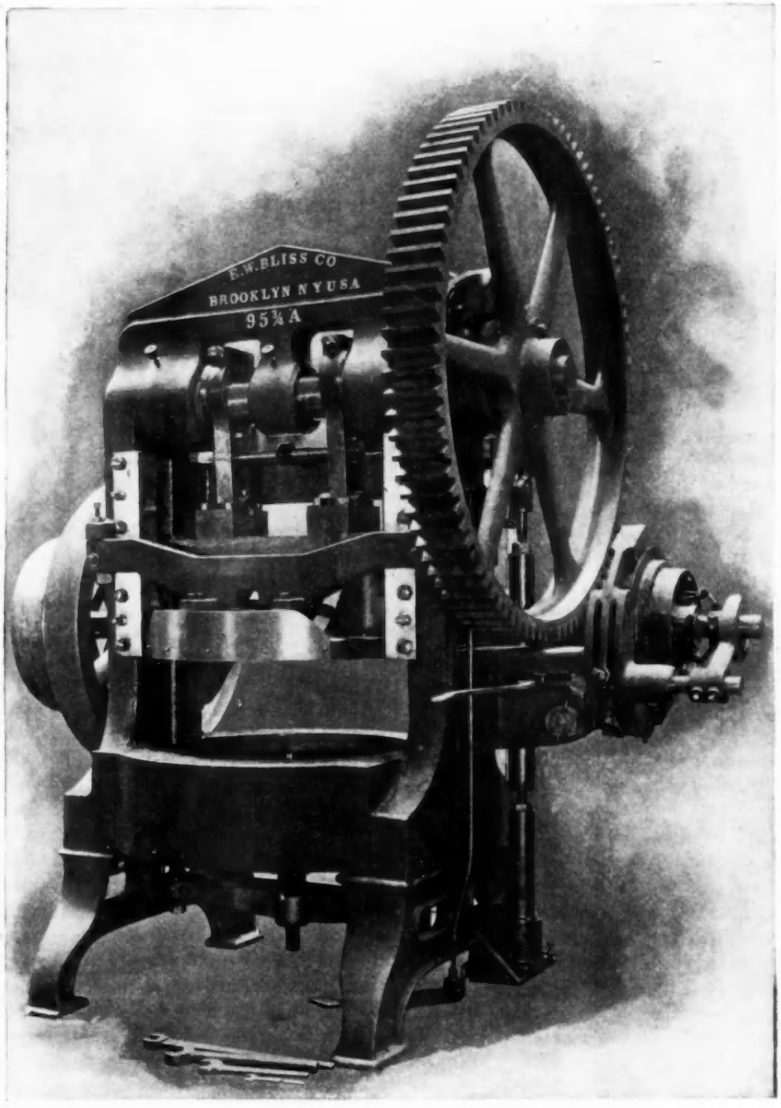


Fig. 1. ARMATURE PRESS WITH POSITIVE KNOCK-OUTS.

This method of punching out completed disks is limited at present, so far as our knowledge goes, to disks of 30 inches diameter. For larger sizes the entire press must be made to suit, leading to a heavy initial outlay for both machine and dies, which increases rapidly with the size of the armature. For large machines the punchings are therefore made in segments, as was clearly shown in the article of the "Great Dynamo" series which appeared in our issue of March 19th, and this system of construction adds very largely to the range of sizes to which the punching of the slots at the initial operation may be applied. Not only is the cost of the outfit for a given size of armature greatly reduced, but the number of pieces necessary for a completed armature, and made with one pair of dies, is largely increased—reaching in large machines many thousands—and it hence becomes practicable to prepare special dies and punch the slots in this way for machines of which but few are expected to be made.

A further refinement of this system of manufacture is seen in Fig. 3, which consists of inverting the dies, whereby the inner piece of scrap is pushed downward instead of upward, and—a little clearance being given to the lower die—it falls through by gravity into a separate pile by itself, instead of being, as with the first plan, delivered into the same pile as the other pieces. This plan obviously requires a hole through the bolster large enough to pass the piece, and this in turn involves a special bolster being made for each set of dies.

For machines of a size or pattern which do not justify the expense in presses or dies for this system, the punchings are made in the same manner, but without the notches—presses of a given strength being able, of course, to punch much larger plain disks than notched disks. After this punching of the blanks, the notches are cut by special notching

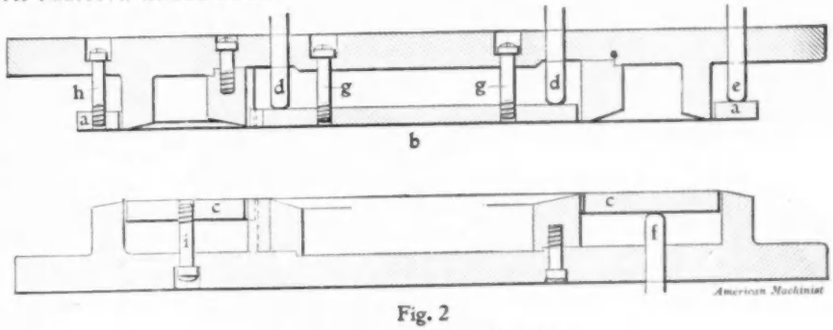


Fig. 2

DIES AND KNOCK-OUT PADS.

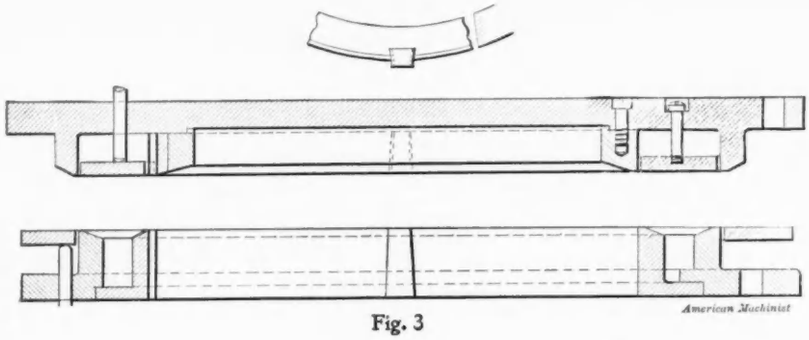


Fig. 3

INVERTED DIES.

presses, one of which was recently illustrated in our columns.

Even this method requires considerable expense for dies, and a third method employs a rotary shear for cutting the blanks, which is shown in Figs. 4 and 5—the former being a perspective view, and the latter showing some of the special points of construction.

Rotary shears are, of course, in common use for cutting out disks where the cutting is entirely upon the outside edge, and deformation of the scrap is of no consequence; but new conditions arise in cutting rings where the inner edge, that formerly belonged to the scrap, becomes one of the finished edges, and deformation or the turning of a burr is not admissible. The chief peculiarity of this machine is in the form and arrangement of the shear blades, shown in both figures, but most clearly in Fig. 5. Instead of the shafts of the blades being parallel, as usual, they will be seen to be inclined to one another in a manner which allows the lower and inner blade to clear the cut surface of the ring without turning up a burr. The clamp plates will be seen to be attached to a deep pair of jaws, which are adjusted upon the supporting bar to the size of cut to be taken. The action of these blades is not the same in both cuts.

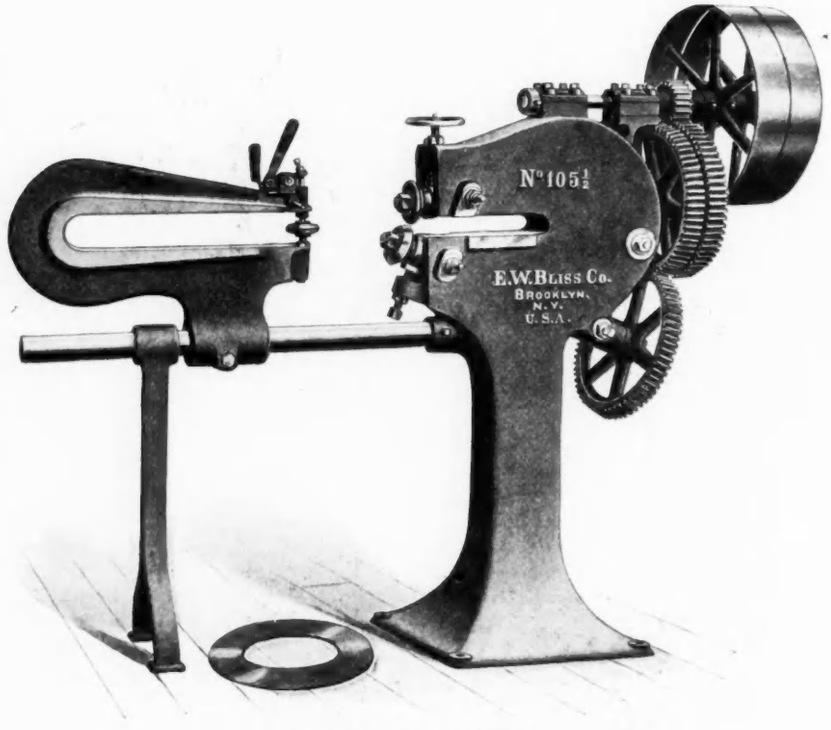


Fig. 4. ROTARY SHEARS.

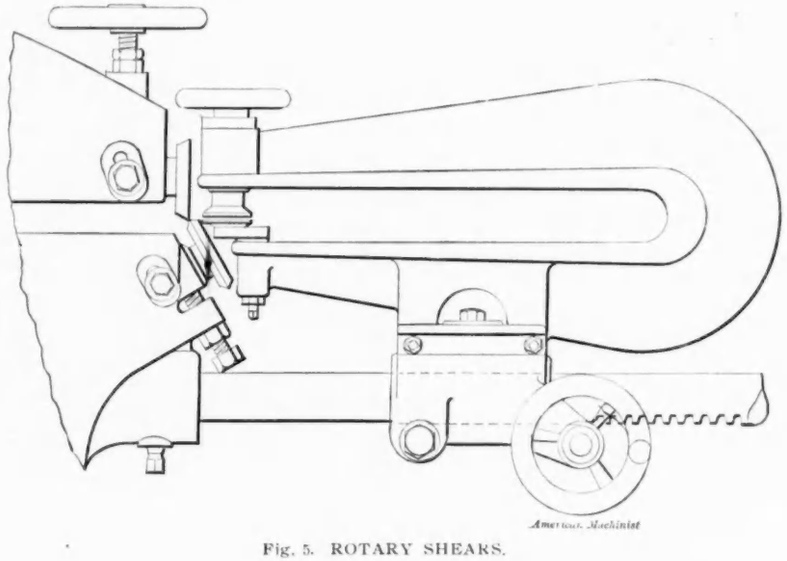


Fig. 5. ROTARY SHEARS.

and provision for adjustment of the clamp plates to suit will be seen in Fig. 5, though not in Fig. 4. The cutting of the outside of the ring is a true shearing operation, the shear blades being set to lap over one another in the usual way, and the cut being made in one revolution of the work. For this operation the center of the clamping plates, must be offset from the line of the blade shafts, as shown in Fig. 6, in which the prick punch point indicates the setting of the center of the clamping plates, to the left of the shear blade center, to a point in line with that where the shearing begins. With the inside circle, however, the blades are opened by the hand-wheel, shown on the top jaw of the machine, to allow the sheet to be inserted, and the top blade is then forced against, but not through, the sheet. The press is started, and the upper blade is then forced further down from time to time until the ring drops off. For this cut the center of the clamping plate must be in line with the shear blade centers, as shown in Fig. 7.

The lower shear blade shaft will also be seen to be carried in a swiveled sleeve or quill, and to be capable of adjustment by the set screw shown. The purpose of this adjustment is to permit the setting of the shear blades after grinding. The grinding is done upon the faces of the blades, which, of course, opens a clearance space between them, and the swiveling of the lower shaft enables this clearance to be closed up. One drawback to this method of cutting the disks is that it requires a separate operation for cutting the

keyway, which is usually done on a slotting machine after the disks are bolted together. When disks are made in a press,

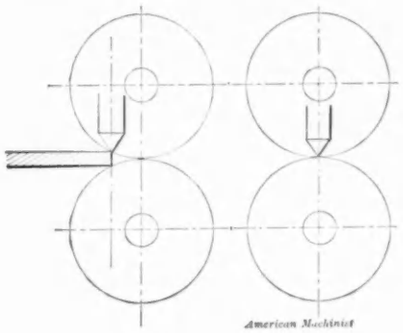


Fig. 6 Fig. 7

ADJUSTMENT OF ROTARY SHEARS FOR INSIDE AND OUTSIDE CUTS.

the key notches are, of course, made by the dies at the same operation with the rest of the disk, the detail of the dies, Figs. 2 and 3, showing clearly how this is done.

▲ ▲ ▲

Letters from Practical Men.

Abuses of the Patent Law.

Editor American Machinist:

The article on "The Way Some Patents Work," in your issue for November 25th, reminds me of two other abuses of the patent law, both of them perfectly safe ways for robbing people under the protection of laws intended to protect them from robbery.

Suppose Smith and Jones conspire together. Smith has a patent, valuable or otherwise, but does nothing about it. Jones, apparently without any connection with Smith, infringes the patent vigorously and sells the machines very cheaply. His profit is not in the sale of the machines, and therefore he can undersell honest manufacturers of the same machine. He keeps track of his sales, and, when the trick is ripe, Smith levies a good royalty on each of the purchasers. The only remedy is to prove that Smith and Jones have conspired together, and they are fools if they have left any chance to do that. In fact, Jones has "skipped" before that time comes. Smith's case is perfectly good. The law gives him a right to sue for infringement, without any respect to the intentions of the infringers. That they are innocent purchasers of the machine, supposing that Jones had the right to manufacture it, is no defense. The law says that "Ignorance of the law is no excuse," and every purchaser of a lawn mower is expected to pay a lawyer a hundred dollars to look up the title to the patent, or take the consequences. Smith wins in two or three cases, and the others must "tumble to the racket" at once, and pay whatever is asked, or else fight and lose more. What is the remedy, supposing Smith's connection with Jones cannot be proved? I do not see any remedy, except to deal only with responsible parties who are not likely to skip out at short notice, and the temptation to purchase at the lowest price is too strong for that common sense.

It appears to me that the law ought to step in in such cases and say that Smith must be limited, not by his ideas of the value of his patent right, but by the judgment of the court or of properly appointed experts.

One great game is to search the patent records for dead and forgotten but unexpired patents which may cover some regular manufacture, purchase them, and then "roast" the manufacturer. Maybe he deserves to be roasted, because he was not careful to hunt up and purchase every interfering patent, but it is a fraud on him just the same. We are a long way behind European nations, who require an inventor to pay a small yearly fee or drop his patent. Our patent records show thousands of useless rubbish patents which have been forgotten by their owners, but which must remain in force simply because they were issued years ago. Most of them will expire and be nothing but a nuisance forever to inventors engaged in searching the patent records, but some of them will prove valuable in the hands of sharpers and help make the patent law ridiculous. If the Government would require a fee of ten dollars a year to keep each patent alive, more than half of them would die young.

The yearly fee, by the way, would stop another nuisance. Johnson invents something, and, to "cover the field," goes to work and invents fifty other devices connected with it, and gets a patent on each. By means of a law that was intended to foster industry, he effectually smothers it. The cost of yearly fees would squelch that trick.

The other game I will call the "foreign reissue" scheme. Formerly it was a great game among patent pirates to hunt up United States patents that were defective in that they did not cover all they described by means of properly constructed claims, and to have them reissued with broad claims carefully planned to cover some manufacture already existing and flourishing. That trick was worked many times until stopped by the celebrated "Bridgeport case," when the court decided that the right to reissue must be confined to correcting evident mistakes, and must not be used to broaden defective claims for the purpose of robbing manufacturers doing business in good faith. That decision was a substantial notice that United States Courts cannot be relied upon to stand in with thieves and their lawyers and be a third party to evident fraud.

But, although the right to reissue a domestic patent was stopped some time ago, the precisely similar right to revamp a foreign patent for the purpose of robbing a manufacturer is still good, although it is likely to follow the old abuse if vigorously fought in court. To show what this is I will cite a real case—real except as to names. One Frant is the manufacturer of a calculating machine, and, as his machine is much better than that made by a rival, one Gelt, that rival casts about for means to stop its manufacture. He gets Johnson, a skillful patent lawyer, to search the European patent records to find something that may be forced, by wringing and twisting the claims, to cover the Frant machine. Johnson understands that branch of his art, and soon finds that a certain gimcrack patented in France seven years ago has devices in it that remotely resemble the Frant ideas. The French patentee sells his right to take out a United States patent to Gelt, and Johnson immediately orders Frant to shut up shop. Maybe he will fight the case instead, for he can certainly show that the case is exactly parallel to the old fraud that the United States Courts have put an end to. This French patent was issued years ago, and the inventor did not take out a United States patent, because he did not want one. But now that an American manufacturer has entered the field, he has a right to come over here and stop him. He has a right, if he has it, that would be denied an American patentee under precisely similar circumstances, and perhaps the United States Courts will allow that, perhaps they will not.

PATENTEE.

▲ ▲ ▲

The Elasticity of Water.

Editor American Machinist:

Your note, in the issue of November 19th, describing the bursting of the hydraulic cylinder, reveals your sharing in an error which is so widely spread and enters into so many phenomena of daily engineering that it is perhaps pardonable to expose it as plainly as possible. This error is that water is incompressible and non-elastic.

To quote our text-book in hydraulics here, Mansfield Merriman's treatise: "The popular opinion that water is incompressible is not justified by experiments, which show in fact that it is more compressible than iron, or even timber, within the elastic limit." It is further shown that the elasticity of water is, in amount, five times that of the latter and eighty times that of the former.

To apply this to the case in hand: Assuming the thickness of the ends to be ½ inch, the internal volume of water in the flask measures 57.57 square inches in area by 5.42 feet long. It would perhaps be simpler to imagine this volume contained in a pipe of 1 square inch internal cross-area. To contain the volume in question this pipe would have to be 311.8 feet long. If it is now to be assumed that a pressure of 5,760 pounds (per square inch) be applied at the end of the colum-

of water, the latter will be compressed, according to the co-efficient given by Grassi, $311.8 \times 0.000045 \times \frac{5760}{1.47}$ feet, or 5.50 feet. When released, the water will expand by a like amount, exerting the mean pressure which compressed it, or one-half of 5,760 pounds. The work done in the "explosion" will be $5.50 \times \frac{5760}{2} = 15{,}840$ foot-pounds.

While the co-efficient given above is not known to be correct for such high pressures, it is probably not far wrong. It is evident that we have no need of recourse to the elasticity of the metal of the exploded cylinder for an explanation of broken pipes and drenched spectators. The figure given above is the equivalent of 288 horse-power acting for $\frac{1}{10}$ of one second.

SIDNEY A. REEVE.

Worcester, Mass.

[We do not share, to any great extent, in any widespread error "which enters into so many phenomena of daily engineering." We share in the practical experience of practical men, and we have no idea that our words misled anyone. While we spoke of "what we all know" about the non-elasticity of water, our next sentence describing the actual result "gave it away." Our correspondent's citation of the actual facts as to the elasticity of water is interesting and will no doubt be welcomed by our readers. The problem, to be treated exhaustively, is much more intricate than suggested above. It is to be remembered that while the water was under compression the metal of the cylinder was under tension. and the force of the explosion was due to the reaction from both of these very opposite conditions. The force contributed by the elasticity of the steel would be in addition to the 288 horse-power for $\frac{1}{10}$ of a second, as computed by our correspondent. We would say that the visible results might have been accomplished by the judicious application of two horse-power for one-tenth of a second. We have seen horses kick.—Ed.]

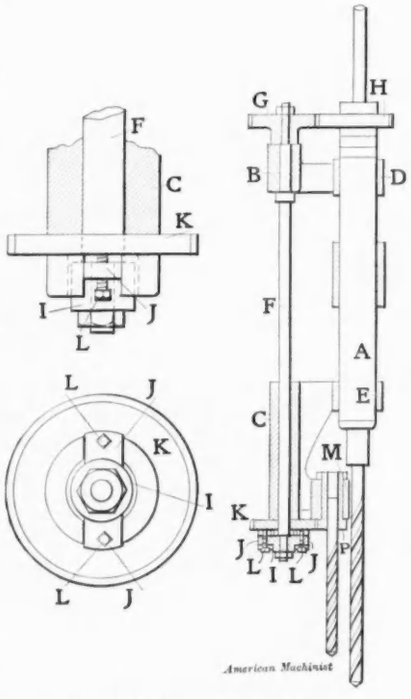
▲ ▲ ▲

An Extra Drill Spindle.

Editor American Machinist:

There are many multiple-spindle drilling machines in the market, but most of them are so constructed that their spindles cannot be moved to drill two holes close to each other at once, especially when the drills are of considerable size. So when it is desired to drill two holes close to each other at the same time, a special machine has to be built for that piece of work. It was once my duty to design such a tool, and it was required that, as there were many drilling machines in the shop, one should be used for the purpose, if an auxiliary spindle could be attached to it to do the work, without too much expense. The holes to be drilled were about 1½ inches diameter, 4½ inches deep; and ⅞ inch diameter, 3 inches deep; and about 2½ inches apart. They were drilled through hardened bushes, into machine steel held in a jig. The chief difficulty was in getting such large drills as close together as required. The following design was executed and found to be entirely efficient:

Upon the sleeve *A* of a drilling machine, two bearings *B* and *C* were attached. The rack on the back of the sleeve *A* was made to answer for a key, and keyways to suit were made in the collars *D* and *E*. These collars *D* and *E* were split and clamped with two screws each after all bearings were bored. This method of attachment allowed of easy removal and the adjustment of the drill points with reference to each other vertically, in order to obtain the required depths of holes. A shaft *F* ran parallel to the spindle of the machine, in the bearings *B* and *C*. A gear *g* was keyed to the upper end of shaft *F*. In mesh with gear *G* was a gear *H*, keyed to the spindle of the drill. Gear *H* was the driver of the whole attachment. On the lower end of the shaft *F* was keyed a driver *I*, the arms *J J* of which fitted into slots in the hub of a gear *K*, which gear was loose on the shaft *F*. Adjusting screws *L*, *L* were tapped through the arms *J*, *J* of the driver *I*, with their ends set against the lower side of the gear *K*, supporting the gear. On the lower end of bearing *C*, parallel to the shaft *F*, and between it and the spindle of the machine, was located a bearing *M*. In this bearing *M* ran the auxiliary spindle, properly tapered within to receive the shank of a ⅞-inch Morse drill. Below the bearing *M*, on the supplementary spindle, was cut a pinion *P*, which meshed with gear *K*. A glance at the accompanying drawing will make it evident that the whole attachment can be fed by the same feeds, by hand or power.



AN EXTRA DRILL SPINDLE.

When it was necessary to raise or lower the small drill to get the proper relative depths of holes, the clamp screws in collar *E* were loosened and the small drill point set by a gage to the point of the large drill. Then the collar *E* was again clamped tight. This will throw gear *K* more or less above or below pinion *P*. By screwing or unscrewing the set screws *L L* the gear *K* may be raised or lowered to compensate for this, while the driver arms *J J* were always kept within the slots in the hub of the gear *K*.

J. LANDSING.

New York.

▲ ▲ ▲

"Established Engineering Practice."

Editor American Machinist:

There are certain natural laws which are fixed and unchanging in their action, and which must of necessity govern and define the forms of all machines employing those natural elements and agencies operating under such unvarying laws.

Fortunately for the science of engineering, these natural laws for one great class of prime movers, the heat engines, are comparatively simple, and are thoroughly well understood by all engineers above the level of those "rule-of-thumb" men, who, in their absurd endeavors to avoid the workings of these natural laws, declare their belief that nothing is so fixed and determined but that its natural course may be changed by some device or trick of mechanics.

Perhaps no machine in use is more entirely under control of unalterable and unavoidable laws than the steam boiler. Because of the vast amount of study and experiment to which the problems of the steam boiler have been subjected, there is no one principal element of engineering practice more thoroughly fixed and settled than that of the form of boiler best adapted to use in certain situations. Thus, none but a "rule-of-thumb" engineer of the rankest description would propose to make a radical change in the form of the locomotive boiler, the marine boiler or the water-tube boiler as they stand to-day, exemplifying as they do perhaps the very soundest and most firmly established results of thoroughly scientific engineering.

It is perfectly well understood, for instance, by all intelligent steam engineers that the water-tube type of boilers, in any of its various forms is wholly unfit for marine use, although these water-tube boilers are very light and small for power developed, and very easily and quickly repaired, and hence, in point of weight, space occupied and up-keep away from

the boiler-shop, might seem to an unscientific engineer admirably adapted for use in steamboats. It is true that some water-tube boilers, notably the "Belleville" and the "Almy," have been placed in vessels by these "rule-of-thumb" men, and that these unscientific engineers have even had the effrontery to claim that their flagrant contraventions of "thoroughly established engineering practice" were successes. The mass of marine construction engineers, however, being thoroughly scientific, and fully informed as to precedent, have wisely declined to be deceived by these absurd claims in favor of water-tube boilers as applied to marine propulsion, and correctly continue to follow established practice with well-tried forms of boilers, which, although heavier, more expensive and more difficult of repair at sea, as well as entailing a far higher stoke-hole temperature than the water-tube boilers, are well known by all scientific engineers to be the only form of boiler suitable for steamship use.

Again, it is perfectly understood that all inclined tubes in water-tube boilers should have their high ends over the grates, and their low ends at the up-take, "because of the immutable action of the laws of heat which can never be avoided or changed or evaded in any manner whatever." Yet, wholly regardless of this thoroughly established engineering practice in the matter of inclined water-tube boilers, and the use of water-tube boilers of any form in steam vessels, a marker-out of boiler forms, who perhaps claims to be an engineer, but certainly must justly fall into that "rule-of-thumb" class which is characterized by an utter disregard of laws and precedent, accepted an order for a design of a marine water-tube boiler, and actually, in order to obtain head room for a steam drum at the more accessible fire-front end of his boiler, this ignoramus inclined his water tubes the other way, making them stand low over the grates and high at the uptake end.

Of course, the educated engineer and the sound engineer who follows established engineering practice can readily understand what followed. The misguided vessel owner who ordered this absurd boiler and the self-styled engineer who designed it, now claim not only that their anomalous construction is a great success, but say that their reversal of the direction of inclination of the water tubes results in a saving of coal, and they have taken steps to patent this outrageous contradiction of "thoroughly established engineering practice," and declare that they expect to see this marine water-tube boiler with its wrongly inclined tubes force its way into general use by virtue of its flagrant departures from recognized practice.

Comment is almost needless, but it seems pertinent to ask what possible inducement is there for an engineer to acquire an education and to make himself familiar with established forms when such ignorant "rule-of-thumb" designers as this water-tube boiler man can find profitable employment, and may even be allowed to pose before the public as improvers in a line which established engineering practice has long declared incapable of betterment? One such example is indeed likely to work incalculable injury to the rising generation of engineers, as tending to overthrow that confidence in tradition and precedent which is the only sure basis of practice for the conservative engineer; and to avoid such a public calamity as the bringing of established engineering practice into disrepute must surely prove, it seems not amiss to suggest that some form of legislative enactment be invoked to define more closely what constitutes a reputable engineer, and to limit the practice of the profession to those who have a due regard for natural laws as understood and applied by their predecessors.

In the present case, if this wholly unscientific marine water-tube boiler should meet with a brief similitude of success (it surely cannot be a real and enduring success, because it contradicts established practice), it may cause great inconvenience to important and highly respectable firms now making boilers of recognized forms, and even have the effect of disordering and unsettling the convictions of steam engineers at large in regard to the theory of steam boiler action, and so lead to great perplexity in the minds of shipowners and builders.

It is possible that all the manifold evils likely to arise from this and other similar cases of flagrant disregard of established engineering practice may be avoided by suitable legislative enactment, and if so, the remedy cannot be applied too soon.

THERMO.

▲ ▲ ▲

Limits of Error in Taps and Dies.

Editor American Machinist:

In microscopes it is required that the screw by which the objective is attached be interchangeable. This screw is Whitworth thread, 36 to inch, with a diameter at bottom of thread of .7626 inch, and at top of .8015 inch. Is it possible to make a number of such taps, and corresponding dies, both in the solid, with a less error than .001 inch either way?

I maintain that it is possible, and that a tap and die guaranteed to a smaller limit of error than $\pm$ .001" can be made for less than £2 15s., or $13.20, the pair. They are to be used only on brass.

What do the American machinists say?

SIR C. PURCELL TAYLOR,
Bart, D. Sc.

London, Eng.

▲ ▲ ▲

When the Air-Pump Bucket Valve Breaks.

Editor American Machinist:

In reply to your question No. 184, October 22d, we wish to say that the engine will have a water stroke if the clappers of the piston break; and if there were no clappers fixed under the piston in a vertical pump, probably the engine would be broken by this water stroke.

A. W. BOLLINCKX.

Brussels, Belgium.

[We have no doubt whatever that the water would make trouble, but we must consider that the suggestion of our correspondent is rather an addition to our answer than in any way contradicting it. —Ed.]

▲ ▲ ▲

Municipal Taxation in Glasgow.

Editor American Machinist:

There is a most erroneous statement in the last issue of the "American Machinist" which I have received. It states that after January next Glasgow, Scotland, will levy no taxes on citizens, as the municipal works make good profits. Glasgow, no doubt, is one of the best-governed cities in the world, but the taxation is very heavy notwithstanding—far above the average of big towns here. There is not the slightest chance of any such cheap living for Glasgow as your paragraph holds out. I can send you confirmation of this if required.

GEO. HARRISON LAW.

Edinburgh, Scotland.

[We condensed the item to which Mr. Law refers from a longer and more detailed account which we supposed to be perfectly reliable, and were the more easily thrown off our guard in the matter by the knowledge that Glasgow is far advanced in the matter of municipal government—controlling and managing in the interest of its citizens many of the those public and semi-public functions which here are left to the management of private corporations and are operated solely for private revenue.—Ed.]

▲ ▲ ▲

Computing Angles.

Editor American Machinist:

It seems to me that the matter of computing angles could be simplified by finding the ratio of $A\,B$ to $B\,C$, in your figure in issue of November 19th, reducing same to decimal and finding corresponding angle to number in a table of natural tangents, which will, of course, be the acute angle adjacent to the base $B\,C$. The other acute angle, of course, is 90 minus the last.

A READER.

▲ ▲ ▲

High-Speed Drilling for Deep Holes.

Editor American Machinist:

Under date of August 13, 1896, and at the foot of page 770, you have an article on "High Speed in Drilling." We note one of your correspondents uses the term "hog-nose drill." We also note he states that this drill runs at the rate of

900 revolutions per minute, which we make out to be 177 feet per minute. Please oblige us, as subscribers to your journal, by giving us a sketch or illustration of this "hog-nose drill." If you will just send us this sketch or illustration, assuring us that the drill will safely stand 900 revolutions per minute, we will not only pay you for your time and trouble, but will write you our very sincere thanks. Awaiting your reply,

THE U. S. METALLIC PACKING CO., LTD.
Bradford, England.

Editor American Machinist:

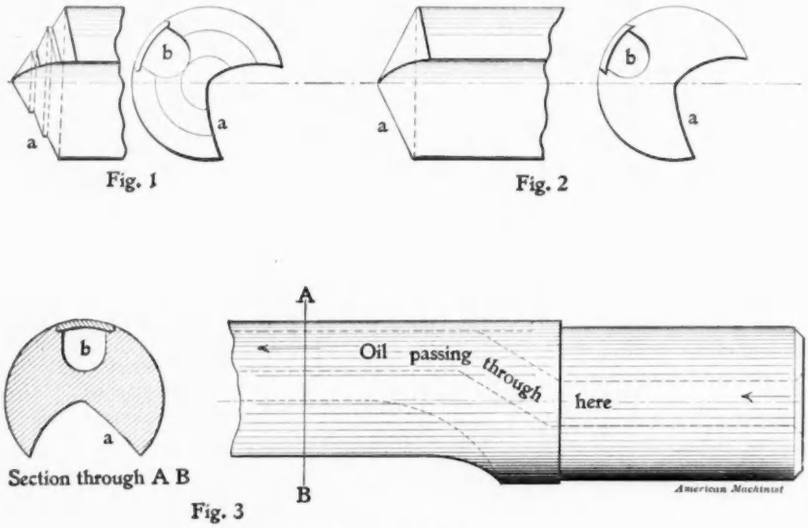
In reply to your favor of the 6th inst., asking for a sketch of the drill which I mentioned in the letter published in the "American Machinist," August 6th, I beg to say that it is with pleasure I comply with your request.

Allow me also to state that the speed which I gave you then is correct; indeed, we are at present doing a little better than at the time the letter was written. I understand that your correspondent is a little doubtful as to the possibility of running a drill at the cutting speed of 180 feet per minute—nor is he to be blamed for his incredulity.

We all know that it is not possible to reach such a limit of speed in ordinary drilling with a twist drill, and the reason for originally mentioning the speed was simply to support my statement, that, practically speaking, "the speed of a drill is limited only by the facility by which we can convey away the heat."

The machines in which the drills of which I speak are used, and also the machines by which they are ground, were designed and built by the Pratt & Whitney Company, of Hartford, Conn., and were originally intended for drilling gun-barrels. For some time, however, they have been used for drilling bicycle connections and parts. To prevent misunderstanding in this matter, allow me to say that these connections and parts are not malleable iron castings, or the like, but that every connection in the bicycles built by us is made from solid drop forging; for instance, the front fork neck is made from homogeneous mild steel, and is a continuous piece together with the fork crown. A 13-16 hole is drilled through its entire length. During the operation of drilling, the piece is revolved at the rate of 1,000 revolutions per minute; this gives a cutting speed at the outer lip of the drill of about 212 feet, and the feed is .0008 of an inch per revolution. That is to say, that the drill cuts .8 of an inch per minute, and the hole 12 inches long is therefore drilled in fifteen minutes.

This is not very rapid drilling. Almost anyone can, with a twist drill, cut a $\frac{13}{16}$ hole at the rate of .8 of an inch per minute. But the great advantage lies in the facility with which deep holes may be drilled, and for such work the twist drill cannot be compared to the one I have described.



A HIGH-SPEED DRILL.

A further advantage in its use is, that one man can easily attend to several machines.

Referring to the sketch, *a* is the cutting edge, *b* is the oil groove covered by a dovetailed strip as shown. Fig. 2 shows one kind of drill; Fig. 1 shows another style.

I consider the shape shown in Fig. 1 to be superior for drills of larger diameter, as the chips come in three narrow shavings instead of one wide one, as from the drill shown in Fig. 2, it being easier for the oil to drive out the chips in the first instance.

Sometimes two steps may be used to advantage instead of three, as shown in Fig. 1.

The drills must be highly finished, well hardened and perfectly ground if success shall be assured. Spindles and chucks must be in practically perfect running balance; plenty of good lard oil must be run through the drill, and a large reservoir of oil must be attached to the machine, in order that it may have sufficient time to cool.

In a $\frac{13}{16}$ drill about two gallons of oil are run through every minute. This is somewhat different from the old way of squirting a little oil over a twist drill from an oil-can; nevertheless, it is still a saving of oil, although two gallons of oil are run through the drill every minute; the oil, of course, returns at once to the reservoir, and is used over and over again.

The reservoir should hold not less than fifty gallons of oil. The way the oil is carried through the shank of the drill, and into the oil channel, is shown in Fig. 3, and the shape of section of the drill is shown best in section *A B*, Fig. 3.

The grinding of the drills is not the least important matter to be considered. A special machine must be had for the purpose, and a free-cutting emery wheel is used for the grinding. It would also be rather difficult to use this kind of drill for any work which is not of a nature that would allow it to be revolved while the drill remains stationary; were the drill to be revolved, the oil connections would be likely to cause trouble.

The drill must, of course, always be started in a bushing; and because neither drill nor bushing revolves, the bushing does not cause any wear on the drill, and it is so constructed that it is left to guide the drill through the whole operation of drilling.

PETER LOBBEN,
Mech. Eng. at Iver Johnson's Arms and Cycle Works.

▲ ▲ ▲

The Illinois Central Railroad Company purchased a Tabor molding machine some time ago and set it up in a foundry near Chicago, where it was used for molding brake shoes and other castings of uniform size. The foundry is in a lonely situation, with few buildings near it. As there seemed to be so few things in the building that would excite the cupidity of thieves, no night watchman was employed. One morning lately, when the man in charge reached the foundry, he found that the molding machine was gone. It was a big machine, weighing about 3,000 pounds, but some enterprising thieves carried it off and left no trace of where they had taken it. They carried off all the attachments and left behind only the foundation.

▲ ▲ ▲

In Mr. Durfee's article entitled "An Ancient Mechanician," etc, in our issue of November 12th, a typographical error occurred which made the date of Serviere's birth 1546 instead of 1596, and thus confounded the chronology of the article somewhat.

▲ ▲ ▲

Of the seven medals awarded by the English Society this year, five go to foreigners.

Opportunities for American Capitalists and Manufacturers in Siam.

Reports have been received calling attention to the opportunities in Siam for American railroad promotors, financial agents, engineering experts, and manufacturers of products and supplies needed in the above projects.

United States Minister Barrett, at Bang Kok, in many of his reports to the State Department, at different times, called attention to just such matters, but he has met with very little response to his efforts; he now states that unless immediate action be taken the best opportunities will have been seized by others. At the present time the promotors of German, British and Danish interests are most active in their efforts to secure concessions and the organization of new schemes.

Such has been the monopolization of these avenues for trade by Europeans that there has been practically no American competition, and still less advertising in American papers for proposals, tenders of bids, etc.; there is not much chance that there ever will be when it can be stated as a fact, as it is by Minister Barrett, that during the two and one-half years that he has resided in Bank Kok not one railway or engineering promotor from America has visited Siam, and this in spite of the fact that, during that time, he has never tired in his efforts to make our people understand that they should at least visit the field. "The energy which Americans have displayed in Korea, Japan and parts of China should be extended to Siam; we obtained important concessions in the countries that I have named, and there is no reason why we should not be able to do so in Siam. So far as location is concerned, Bang Kok is as easily reached from Hong Kong or Singapore as Seoul is from Yokohama, and with more ease than we can get from Pekin to Shanghai. The Government of Siam is as favorable to foreign interests as are the Governments of either Korea or China, and there would be no great difficulty in presenting any schemes of a reasonable nature, and obtaining a hearing for the same, or in securing concessions, providing they have not already been promised."

Several important plans are now being projected which should be of interest to American contractors and manufacturers, most important of which is a railroad running west and south from Bang Kok to Ratburi to Petcharburee, a distance of about one hundred miles, with a prospect of continuing the same, at a later date, down the Malay Peninsula. It is understood that the Siamese Government intends to build this line from its own funds, and that the work will commence early in the coming year, and there is no reason why at least a portion of the material, supplies and equipment should not come from America. This is deemed to be one of the most important undertakings in Southeastern Asia, and it is possible that it might become a link in the proposed Siam-China line which will reach from the Bay of Bengal to the China Sea. Other lines are being talked of, and among them several electrical lines.

Under the head of engineering propositions, Minister Barrett states that it is certain that, in the near future, Bang Kok must arrange for a permanent and healthful water supply, and this alone would require an expenditure of more than a million of dollars; a system of sewerage is also an urgent necessity.

At the present time, special agents of German and British capitalists and manufacturers are in Bang Kok, and they are leaving no stone unturned, not only to get every concession possible, but to get every contract that is open. American agents should be right alongside in the contest; and should the prospects not be deemed of sufficient importance in Siam to warrant sending out special men, it must be remembered that there is an ever-increasing interest all along the coast of Eastern Asia, from Yokohama to Singapore, and capable representatives could travel all through these countries, and the best time of the year for such a trip is between the months of November and February.

▲ ▲ ▲

"La Grande Duchesse."

The above is the name of one of the latest products of our American shipyards, and, notwithstanding the name, she is American throughout, in design, material, construction, equipment and personnel, and is to run between American ports. She was built by the Newport News Dry Dock & Shipbuilding Company (her hull being No. 15 of that establishment) for the Savannah Line of the Plant System of ocean steamships.

The ship is 404 feet long over all, 380 feet between perpendiculars, 47′ 9″ beam, and 37′ 4″ deep from top of deck to base line; draft 24 feet; gross tonnage, 5,017; net tonnage, 3,006. She is principally a passenger boat, and has excellent accommodations for 591 first-cabin and 131 second-cabin passengers. The state-rooms are provided with every refinement of the most pretentious of the transatlantic liners, and everything pertaining to the vessel is of the latest and best in marine architecture.

The ship, of course, has twin screws. The engines are quadruple expansion, the cylinders being 24, 34, 48 and 68 inches diameter by 42 inches stroke. The high-pressure cylinder is forward and the others range aft successively. The first two cylinders of each engine have piston valves, the others being flat valves. The valves are operated by link motion, with a separate adjustment for each valve in the go-ahead position. Each shaft is composed of seven pieces, two cranks on each of the first two lengths, then the thrust shaft, three plain lengths, and finally the screw shaft, all the similar pieces being absolutely interchangeable.

The steam is supplied by eight Babcock & Wilcox boilers, standing back to back in two rows fore and aft, with a donkey boiler on the deck above. The steam pressure carried, or allowed, on the main boilers is 225 pounds. We cannot even attempt to mention the auxiliary engines for the various services required on the modern ship, as some of them might escape us in the enumeration. There are, for instance, sixteen double-acting steam pumps.

The most noticeable feature, perhaps, of the entire machinery equipment is the perfect accessibility of every part. Everything can be got at apparently almost as easily as when the engines were in the shop under construction. The ship, all in all, is a beauty, and one that the owners, the crew and the general American public may all be proud of.

▲ ▲ ▲

The American Foundrymen's Association.

The Secretary of the American Foundrymen's Association reports that their organization now has a membership of over 200 and that the number is rapidly increasing, and that more applications for membership have been received since November 3d than during two months previously.

The Board of Directors are now considering the advisability of putting into practical form some of the purposes for which the association was organized, among these being the adoption of a uniform apprenticeship system, to the end that its members may be protected in their efforts to improve the standard of the American mechanic, in order that the present universal complaint concerning their scarcity may as far as possible be altered for the better.

They are also considering the advisability of adopting some measures for protecting the members of the association at all times from the unfair exactions of labor organizations, as well as the attempt occasionally of one employer to take the advantage of his competitors by reducing the wages lower than the rest.

The success attending the Stove Founders' Defense Association in this direction has served as an incentive, and it is almost certain that committees will be appointed to report on both of these projects at its next convention, which is likely to be held in the city of Detroit.

▲ ▲ ▲

Secretary Herbert has awarded contracts for forgings for fifteen large guns as follows: Eight sets 13-inch gun forgings to the Bethlehem Iron Works, deliveries to begin within 120 days; six sets 13-inch and one set 12-inch forgings to the Midvale Steel Works, deliveries to begin within 160 days. The price in each case is 23.8 cents per pound.

American Machinist.

Published every Thursday
by the

American Machinist Publishing Co.,
256 Broadway, New York.

Angus Sinclair, Pres't. John A. Hill, Treas.
C. A. Hansmann, Sec'y.

C. P. Day, Manager Adv. Dept.

Fred J. Miller, Editor.

Frank Richards,
F. A. Halsey,
Edward P. Buffet,
} Associate Editors.

A. L. Donnell, Dept. of Illustration.

▲ ▲ ▲

Space in advertising pages only is for sale.

We invite correspondence on subjects pertaining to machinery.

Name and address must always be given, though not necessarily published.

Communications for or relating to the reading columns should be addressed to the Editor. All business communications should be addressed to the Company.

Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.

▲ ▲ ▲

SUBSCRIPTION PRICE:

$3.00 a year in advance, postage prepaid in the United States, Canada and Mexico.

$4.00 a year to other countries, postage prepaid.

Entered at Post Office, New York, as second-class mail matter.

For Sale by Newsdealers. Everywhere.

▲ ▲ ▲

Use Steel Adapted to the Purpose.

It cannot be too often nor too strongly insisted upon that the best possible results cannot be obtained from the use of tool steel of any make, either foreign or domestic, unless the particular bar of steel used has been made for the specific purpose for which it is to be used. Incidents are constantly arising in the shop which demonstrate the importance of this, and some of the latest may be stated about as follows:

A large shop requiring tool steel for working other steel of such a quality as to make it difficult to handle, bought some tool steel in bars 1½ inches square. Now, it happens that bars of steel of this size are usually, or at least often, employed for making chisels and other blacksmith's tools which are struck by the sledge hammer, or sometimes used under the steam hammer, and must be capable of withstanding heavy blows. Such bars are therefore, unless specifically ordered for a different purpose, usually made low in carbon, and this unfits them for such a purpose as lathe or planer tools, regardless of their quality. This concern happened to want some slotter tools, and as this bar was the right size they made them from it. The tools were, of course, nearly worthless; and instead of recognizing that this was simply a case of using a steel for one purpose, designed and made for an entirely different purpose, they condemned the steel and complained to the steel-maker that his product could not be depended upon.

An exactly similar thing occurred in the case of a railroad company which made planer tools out of a 1½ inch square bar, and attempted to use these tools for planing steel rails in making frogs. The steel, though of good quality, was so low in carbon as to be almost utterly useless for this purpose, and the steel-maker very soon received a vigorous complaint of the quality of his steel. He had to visit the shop and see what they were using it for before he could get any further information than that simply "the steel is unsatisfactory." When he found them using it for planing steel rails, he explained to them that he could send a bar of the same size, of the same quality and at the same price, which would do ten times the work that the present tools were doing; it was only a question of carbon, but that this higher carbon steel would be utterly unfitted for blacksmith's tools such as chisels, etc., because under such treatment it would inevitably break off, fly about the shop, and be dangerous to the eyes and perhaps the lives of the workmen.

It seems to us that in this enlightened age there is little excuse for steel-users regarding steel as divided in four classes, i. e., tool-steel, machinery steel, good steel and bad steel. They ought to know that very much depends upon the percentage of carbon; that steel-makers simply guess at this when they do not know what the bar is to be used for, and that they would prefer to know, so that by giving the proper amount of carbon they can get the best possible results for the given quality of steel; quality being a matter which has little or nothing to do with the percentage of carbon.

▲ ▲ ▲

Self-Propelled Vehicles in England.

A great and rapid increase in the number of self-propelled wagons and carriages is generally predicted in England. Sir David Salomons, in a recent speech at Liverpool, said:

"The great and immediate future of self-propelled traffic in England will be in connection with trade. The sporting element of society will never be induced to give up their horses, and the poorer gentry and small tradesmen cannot afford to purchase motor carriages until they are assured that a really satisfactory vehicle can be obtained. There will, undoubtedly, soon be seen on the roads a very large number of motor delivery vans for railways, factories, shops and other business houses, for the simple reason that they will not wait for the little refinements required in a private carriage, and the cost of replacing their vans at a later period will not be an important matter."

It is predicted that within a few years all the heavy traffic and the public conveyances will be self-propelled, but it is not thought that the oil motor will be generally adopted. Much is still expected of the steam vehicle, which has been so long held back by absurd and antiquated laws. It is claimed that the steam carriage is, after all, easier to run, cleaner, less liable to get out of order and cheaper. The possibilities of the steam carriage would seem to be worthy of a little more investigation in the United States. It is to be remembered that the motor wagon, of whatever type, does not get tired and one can be made to do the work of four or more horses or pairs of horses, which fact should not be lost sight of in estimates of comparative costs of operation.

▲ ▲ ▲

Second Annual Convention of the National Association of Manufacturers.

The date for holding the Second Annual Convention of the National Association of Manufacturers has been fixed for the 26th, 27th and 28th of January, 1897, at Philadelphia Pa. It is expected that this convention will be one of unusual interest, as the president will submit a report of the first full year of practical work in the lines mapped out by the original convention held in Cincinnati, January, 1895. This report will describe the initiation of practical movement in the direction of the cardinal principles originally adopted by the association, and very gratifying progress in various directions will be noted. It will then devolve upon the convention itself, which will embrace the recorded members holding certificates in the association, to pass upon the work which has been done, and to indicate a policy to be pursued by the president and executive committee during the next year; in which year it is confidently expected that existing conditions will enable the association to make vigorous progress.

▲ ▲ ▲

Experiments by Lieutenant-Colonel English and Mr. Bryan Donkin, and reported in a paper to the English Institution of Mechanical Engineers, show that the amount of heat which can be transmitted through surface condenser tubes, under laboratory conditions, is from seven to twelve times that realized under the conditions of practice. Room for improvement is certainly indicated here.

▲ ▲ ▲

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(201) S. H. R., Perth, Ont., asks: When a steel-maker speaks of steel 5 to 7 points carbon, does he mean 5 to 7 one-hundredths of 1 per cent., or 5 to 7 per cent.? A.—Each point of carbon in steel is one-hundredth of 1 per cent. 2. What is the ordinary proportion of carbon in open-hearth steel tires for car wheels? A.—Such steel usually

runs from 0.60 to 0.70 carbon, and will have, approximately, 115,000 pounds per square inch tensile strength, with an elongation of 14 per cent. in 4 inches.

(202) A. R., Evanston, Ill., asks: Is it practicable to draw air through a 12-inch tube, 10 miles long, using a Baker blower; velocity of air about 50 feet per second, and maintaining a suction of 12 ounces per square inch at the end farthest from the blower? What would the suction have to be at the blower to maintain the suction of 12 ounces per square inch at the extreme end? A.—It is not practicable, because it is very far from being possible. It is not worth while to go into the matter very thoroughly. A table published by the B. F. Sturtevant Company gives the loss of pressure in a 12-inch pipe with air flowing 50 feet per second, or 3,000 feet per minute, as 0.833 ounce for each 100 feet of length. Then for 10,000 feet, or less than one-fifth of the length proposed by our correspondent, the loss of pressure would be 83.3 ounces, and the "vacuum" required at the blower for the 10,000 feet of length would be $83.3 + 12 = 95.3$ ounces, or, say, 6 pounds.

(203) C. W., Newark, N. J., writes: I have a steam plant that is not working satisfactorily. The boiler is 54 inches diameter and 14 feet long, with 64 3-inch tubes. The grate is 5 x 5 feet, and the chimney is 18 inches diameter and about 50 feet high. The gases, after passing through the tubes, return over the top of the boiler, which is all inclosed, and then through a flue 20 inches square. The chimney is of 18-inch glazed sewer pipe with brick outside, and is about 12 feet from the boiler. The pressure carried is 80 pounds. The engine is a plain slide-valve engine, 10 x 16 inches and 170 revolutions per minute. It is in very bad condition. The cylinder is out of true, piston leaks and also the valve, so I don't blame the boiler, but would like to know if the chimney and grate areas are all right. The boiler is rated at 60 horse-power, and I have hard work to furnish steam for a 38 horse-power engine. We have free-burning pea coal and use about 1,950 pounds per day of ten hours. A.—We would say that the chimney is certainly too small. It should be at least 24 inches square, or 27 inches diameter if round. The grate area is plenty large enough, and, since it is so much wider than the boiler, it might be well to narrow it somewhat by laying up a course of bricks on each side. It is not now considered good practice to inclose the top of the boiler with a flue; no appreciable economy results from it, and it is bad for the boiler shell. We do not know why the engine should be called 38 horse-power, as, under the conditions given, it might easily be much more than that. Supposing the mean effective pressure to be only 50 pounds we would have: $10^2 \times .7854 \times 50 \times \frac{8}{9} \times 170 \div 33{,}000 = 53$ I. H. P. As far as we can see into the case, the coal consumption would not seem to be extravagant.

(204) A. R. M., Cincinnati, O., writes: Please enlighten me as to how the divisions on a universal dividing head are found. Supposing a head to have a worm of 4 threads per inch, and the worm wheel to have 40 teeth; how would you find what circle of holes to use, or number of holes to skip? Please give an example of how it is computed, taking an uneven number, such as 73, and an even number, say 72. A.—In the first place we need pay no attention in this problem, nor in any similar one, to the number of threads per inch on the worm. If the worm wheel has 40 teeth and the worm has a single thread, then the ratio is 1 to 40, regardless of the pitch of worm or wheel. This means that the worm wheel is rotated $\frac{1}{40}$ of a revolution for each complete revolution of the worm or index pin, and to revolve it any given fraction of a revolution, we need only give the worm such portion of a revolution as is proportionate to the given fraction, as 1 turn is to $\frac{1}{40}$ of a turn. Thus, taking your first example, we see that the required fraction of a revolution is to $\frac{1}{73}$ as 1 is to $\frac{1}{40}$, and from this it can be solved by the ordinary rule of proportion, as given in the arithmetics. A more practical method for shop use, however, is to write a common fraction with 40 as its numerator and the required division as its denominator. This in the case assumed gives us $\frac{40}{73}$, which is the fraction of a turn necessary to turn the index pin. In this case 73 is a prime number, and the fraction cannot therefore be reduced to lower terms. This shows that that number cannot be indexed in the ordinary manner unless we have a plate with 73 holes, but it can be indexed by the compound method, which has been explained in these columns and is treated fully in the Brown & Sharpe Manufacturing Company's "Treatise on the Milling Machine." The nearest possible division for this number is 73.0001, which, of course, is practically exact. It is obtained by moving the index pin $2\frac{32}{40}$ revolutions, and then moving the plate $\frac{8}{49}$ of a revolution in the same direction, for each cut, going six times around the work to complete it. Indexing 72 is much simpler. Here we have the fraction $\frac{40}{72}$, which reduces to $\frac{20}{36}$ or $\frac{10}{18}$ or $\frac{5}{9}$. This means that the fraction of a turn required is $\frac{40}{72}$, and that $\frac{20}{36}$ or $\frac{10}{18}$ or $\frac{5}{9}$ are any one of them the same thing, and that by moving the index pin 40 holes in a 72 circle, or 20 holes in a 36 circle, or 10 holes in an 18 circle, or 5 holes in a 9 circle, we shall index 72.

▲ ▲ ▲

Business Specials.

Transient Advertisements 40 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear wheels, gear cutting. Grant; see page 14.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Ideal Twist Drill Grinder. T. Hall, 853 B'way, N.Y.

Engine Castings ⅛ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Presses and dies for bar and sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Just Issued—Catalog No. 8. Mailed free. Clayton Air Compressor Works, 28 Cortlandt st., New York.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

▲ ▲ ▲

In a discussion about water tubes in boilers now going on in the "Mechanical World," London, a writer states that he employs boiler-makers "60 inches round the stomach, who can go anywhere about a 7-foot boiler," and another writer thinks the statement should be taken "with a little salt," as the manholes are only 16 inches diameter or 48 inches in circumference.

▲ ▲ ▲

The recent fire in the foundry of the E. Horton & Son Company, Windsor Locks, Conn., has not prevented the running of the other departments of their works, and they state they are ready to fill orders as promptly as heretofore.

▲ ▲ ▲

An event of some importance to those interested in small arms and their manufacture, is the consolidation of the Winchester and the Remington establishments, this having been accomplished by their mutual connection with Hartley & Graham, of New York. It is reported that it is the intention to remove both the Ilion and the New Haven works to Bridgeport, Conn.

▲ ▲ ▲

Literary Notes.

THE "PRACTICAL ENGINEER'S" POCKET-BOOK. 342 3¼ x 5½-inch pages, with many illustrations. Price, 18 8d.

Some of our English exchanges follow the excellent plan of publishing, at a low price, pocket books wherein are collected the more valuable of the data published in their columns, together with additional tables and other matter commonly found in such publications. This is one of this class of books. It is well bound in leather, although not very well printed. Its price is astonishingly low, and we have no hesitation in saying it is a better value for the investment than any similar book which has come to our knowledge. It includes a wide range of information and has a very superior index, which doubles its value.

A PRACTICAL TREATISE ON THE OTTO CYCLE GAS ENGINE. By Wm. Norris. 260 6 x 9-inch pages; 207 illustrations. Longmans, Green & Co.

This is an excellent and very timely book. It contains very little theory, but is distinctly a treatise on construction. Every page gives evidence of the author's thorough acquaintance with the subject. Every detail is thoroughly discussed, and numerous engravings of constructive details, as furnished by different builders, are given. These builders are entitled to a share in the credit for the result, for nothing but the most liberal spirit could have furnished such a profusion of drawings. The whole forms a book of a kind which everybody wants, but, in most fields of work, seldom finds. The engravings are, from the American standpoint, inferior. We are not much given to horn-blowing, either for ourselves or for the country at large; but it is undoubtedly true that Americans excel in the art of making engravings of the kind used in publications of this character. In line engravings or diagrams, particularly, we see no such results either in foreign books or periodicals as those which appear in our own columns from week to week.

MODEL OF A HORIZONTAL STEAM ENGINE FURNISHED WITH MEYER'S VARIBLE EXPANSION GEAR. By C. Volkert. 25 7½ x 10-inch pages; 15 illustrations and folded inset. Thomas Whittaker, American Agent. Price, $1.

This publication is scarcely correctly described by its title page. It is really an elementary book on the steam engine,

with portions, especially on valves, which are not so elementary. The whole is supplemented with a folding inset comprising eight plates for elucidating the action of the Meyer valve. These give Zenner diagrams, elevations and sections, the latter being in parts laid one over the other, which, when turned down, show additional sections to the rear. It is from these plates that the book gets its name of "model." The parts do not move upon one another, and the inset is in no sense a working model. Beginners with few means of access to the interior of engines will find it a useful help in their studies.

▲ ▲ ▲

Commercial Review.

NEW YORK, SATURDAY EVENING, NOV. 28.

DYNAMOS AND MOTORS.

Unquestionably the dynamo and motor market has improved somewhat since the Election. As has been found to be the case in other of the mechanical branches of trade, the improvement is not what sellers expected—if they expected anything very startling; yet not only is the undertone of this business stronger than it has been, and inquiry better, but sales are reported by a number of houses to have increased in volume.

A notable street railway contract has just been given out in this city. The Third Avenue Railway Company have placed an order for the electrical equipment of their new Kingsbridge line, amounting to about 3,000 horse-power, with the General Electric Company. The new road will be ten miles in length and will open up a strip of comparatively wild land in the Northern part of Manhattan Island, which is expected to cause a flurry in real estate speculation in that region.

Among the November sales of the Walker Company were several orders for dynamos and motors for railway purposes, to be shipped to Antwerp, Buenos Ayres, St. John, N. B., and elsewhere. Another was for 30 quadruple equipments (120 motors) for a railroad in Upper Silesia, Germany, to displace steam power now in use there.

Two sizeable contracts have also been placed with this company for lighting generators, to be installed in office buildings in this city; viz., those of the New York Life Insurance Company and the Central Syndicate building. Lighting generators are said to have improved in tone along with the rest of the dynamo and motor market, though when the buildings in which they are to be placed are those now in process of construction, it is hardly to be supposed that the Election has much affected the results.

A healthier tone is acknowledged to exist also in motors for factory power, etc., although this class of work has not started up as it is expected to later on. In the electrical, as in the steam-power machinery business, there is beginning to be talk of next spring as the time in which to see a brisk trade. And right here we want to digress a moment in order to deprecate the tendency to harbor these sentiments of procrastination. There may be some things which will postpone a business revival with good excuse. Such was the Election we have just passed through, and such would be a war-scare, were we somewhat less habituated to them than we are; but why must activity of trade always be deferred until after some arbitrary future event, and business men forever act the part of a Tantalus? For months past everying has succumbed to the Election, now "inventory time" is in the way; then it will be "midwinter dullness," then the Tariff bill, probably; then "midsummer dullness," and by the time we get around to the inventory period again half a dozen new catastrophes may have occupied the foreground. And, incidentally, does a dollar's worth cost any more just before inventory time than just after it?

An indication that increased attention is being paid to the export side of the market would seem to be contained in the fact that the Crocker-Wheeler Electric Company have placed an agency for their machines for Mexico and other Spanish-American countries in the hands of Mr. Thos. G. Faye, formerly general manager of the C. & C. Electric Company, and now electrical engineer and contractor at 143 Liberty street, New York.

A cause now affecting the export trade of electrical, and presumably of other, machinery to Mexico and the Northern part of South America, is the stage of the rainy season which these countries are undergoing, and which causes, to a considerable degree, a cessation of business with them. Although it may be that a full resumption will not take place during the winter, it is said that even thirty days will make a difference.

SOME GENERAL OBSERVATIONS.

It may be well to add to the remarks we made last week as to the necessity of qualifying the current newspaper reports of renewed industrial activity, the following illustration which has subsequently come to our notice: A certain establishment in Pennsylvania, engaged in engineering pursuits, just after the Election, opened its doors to activity and to all the newspaper men who would enter and see what big things were being done there. After three days of prosperity and éclat the doors were closed.

The Davis & Egan Machine Tool Company write us that they have, during the past ten days, taken some large orders from bicycle factories, electrical manufacturers, brass shops, founders, machinists, paper mills, etc., showing an improvement not confined to any particular line.

A consular report, published in the November volume of such reports, states that an exhibiton of power and labor machines is to be held at Munich, Germany, in 1898. It is to be an international affair, and Americans are invited to participate and compete for the awards.

EXPORTS OF MACHINERY

from the port of New York, of which manifests have been given out from the Custom House during the week ending November 28th, we compute as amounting to $263,000. These figures include locomotives, boilers and boiler tubes, pumps, windmills, etc.

THE IRON MARKET

is quieter, as is inevitable after a fairly heavy buying movement which took place at an earlier date. A lull is expected to continue during December, with hope of recovery after the first of next year.

A feature of the past week has been the publication of stories as to the dissolution of the nail pool, final action in regard to which may take place this week. It is said that a combination of lock manufacturers is now being formed. Our Pittsburg letter, given below, apparently presents the more hopeful side of the situation of the iron market.

PITTSBURG REPORT FOR NOVEMBER.

The long-looked-for improvement is gradually shaping itself. In all lines of the iron trade a better demand is being experienced, and the prospects are very good for a fair amount of work during the coming winter. There are no signs of a boom, and those who expected one, and prophesied such, are disappointed. There is no doubt that the effects of the Election are already being felt in trade. From all sides come statements of more active business, better prospects and a more abiding faith in the future. This is particularly true in the iron and steel trades. Quite a number of mills and furnaces, which have been either running sparingly or shut down entirely, are preparing to resume operations. A great many have already started, but not to full capacity by any means. Engine and machinery builders seem to be feeling much better than a month ago.

But with all these fair prospects, we should not expect too much. While it is true we should take the most cheerful view of the future, some daily press reports seem to be overdoing it, as statements sent abroad, of new work and new establishments, have in numerous cases been exaggerated. It cannot be expected that a depression such as this country has suffered from for the past four years can be removed in so short a period. It will take some time for business interests to recover. Much as some manufacturers desire to put up new plants, or extend their old ones, it will take time to arrange plans, negotiate for buildings, etc., before the actual commencement of work.

The season of the year is now against us. The winter, usually the dull season, will afford time for preparations; but

(Continued on page 37.)

Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our subscription list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Help Wanted—Good pay for leisure hours. Geo. W. Lord, Philadelphia, Pa.

Mechan'l eng'r and dr'ftsman, Stevens graduate, wants sit.; highest ref. Box 191, AMER. MACHINIST.

Draftsman, technical graduate, exp. in shop and drawing room, wants position. Box 178, AM. MACH.

Experienc'd mech'nical drftsman wants position; best references. A. Seewaldt, 10 Ave. C, New York.

Wanted—An up-to-date boiler maker on marine work to act as foreman. Address Phœnix Iron Works, Port Huron, Mich.

Practical and successful designer, A 1 draftsman, 20 years' varied experience, designer of high grade engines, desires position. Box 263, Ridgway, Pa.

Wanted—Drftsman accust'd to small work-jigs, tools, &c.; must have pract'l ideas. Address stating exper. and salary expected. Box 187, AM. MACH.

Pattern maker wishes position as foreman; capable of turning out high grade work; competent; good references. Box 189, AMERICAN MACHINIST.

A supt. of a concern employing 450 men is open for engagement; thoroughly familiar with shop and foundry practice; also estimating upon new work. Box 188, AMERICAN MACHINIST.

Wanted—Position in charge of machine room of bicycle works by reliable tool maker, aged 34; experienced with Cleveland and other automatic screw machines. Box 186, AMERICAN MACHINIST.

Reliable draftsman, quick and neat, 9 years' drawing room and shop experience, college education, speaking English, German, some French, desires change; good refs. Box 184, AM. MACHINIST.

Gun and locksmith wanted in a Montana city; must be a first-class mechanic, thoroughly experienced and a man of deeds, not words; give experience, age, references and wages wanted. Address L. G., AMERICAN MACHINIST.

Foreman would like to correspond with some agricultural manufacturer who wants a good foundry foreman; 18 years' experience; good reference; will pay personal visit if desired; write for particulars. Box 190, AMERICAN MACHINIST.

Assayer and Draftsman—Position open West for an energetic technical graduate, as assistant engineer to manager; great variety of work outside and in office; give references, age and experience. Address L. G., AMERICAN MACHINIST.

Foreman would like to correspond with Corliss engine builder who wants foundry foreman; experienced in all branches of the business; good references; will pay personal visit if desired; write for particulars. Box 160. AMERICAN MACHINIST.

Do you wish to reduce expenses?—An energetic supt., 35, desires change; is thoroughly reliable and can come well recommended; machine tool shop pref'd; capable of taking entire charge of plant and is not afraid of overwork. Box 192, AMER. MACH.

An experienced engineer is open to engagement where ability and well-directed push can be made advantageous to both parties; refers to many well-known engineers; graduate of Cornell; member of American Society of Mechanical Engineers. Address Box 174, AMERICAN MACHINIST.

The undersigned would be pleased to correspond with manufacturers requiring the service of a hustling superintendent of practical abilities and extensive experience in the manufacture of dynamos, motors and general machinery; salary or contract acceptable; prefer the latter. Box 180, AM. MACH.

Foreman boiler-maker wanted—First-class man who is familiar with marine and stationary boiler and iron ship work. Applicants will state age, experience, nationality, give names of previous employers, and must be well recommended. Address Waring & Dixey, 2033 American Tract Building, N. Y. City, N. Y.

Owing to a consolidation of business, a successful mechanical superintendent will be at liberty January 1st. Experienced in general shop and business management, costs, interchangeable work, tools, gauges, etc.; also general machinery and brass and iron work for steam, gas and water; strictly temperate and reliable; eight years in present position. Add. Box 168, AMER. MACHINIST.

A thorough machinist, age 36, who has been engaged in the machine and foundry business, desires to connect himself with some reliable firm where ability and push will count; well up in modern shop methods and management; can handle men, make drawings, solicit business, make contracts or handle correspondence; can give unqualified references as to character and ability. Box 179, AMERICAN MACHINIST.

Representatives for New York and Chicago Wanted—Two thoroughly competent solicitors to represent and advocate work for a machine shop (cap. 250-300 hands) that is equipped with the finest modern implements and prepared to do general machine work, especially in the line of automatic machinery, labor-saving machines, tools, work of precision, etc., under contract or regular shop rates; must be practical men with unlimited experience and able to give estimates; only A 1 men with A 1 references need apply. Address Box 177, AMERICAN MACHINIST.

▲ ▲ ▲

Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d h'd lathes & planers. S. M. York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Light and fine mach'y to order; models and electrical work specialty. E O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

We offer an exceedingly fine lot of first-class second-hand machinery, lathes, planers, shapers, drills, millers, screw machines, etc. Call, or get list 17 B. The Garvin Mach. Co., 440 Canal st., N.Y.

Wanted—An Idea. Who can think o some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offered to inventors.

3 Inch 4 Cuts.

1¼ 2

WOOD PLANERS.

▲ ▲ ▲

26″ and 32″ wide. Double feed, very powerful, can make a ¾″ cut. Suitable for heavy or light or very short stock. Cutter head of solid steel forging. Can plane up to 10″ thick.

Outboard Bearing on Cutterhead.

Absolutely smooth and uniform work. No clipped or wavy ends.

26″ weighs 3200 pounds.
32″ weighs 3650 pounds.

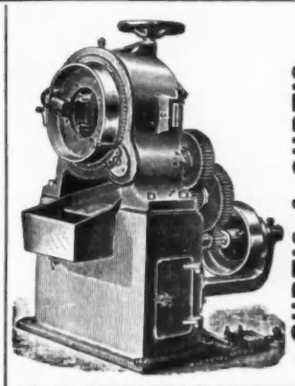
A few on the Bargain Counter.

Send for Catalogue "A."

P. PRYIBIL,

524 West 41st Street, New York.

Cables, "Pryibil, Newyork."
Use A.B.C. Code.



CURTIS & CURTIS,
66 CARDEN ST., BRIDGEPORT, CONN.
Pipe Cutting and Threading Machinery,
FOR HAND OR POWER,
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

Patents PROCURED or NO CHARGE for service. *32 Years' Practice.* RELIABLE SERVICE at MODERATE RATES. Daily attendance in Patent Office. Good References.
CHAS. J. GOOCH, Attorney, 615 F Street, N. W., **WASHINGTON, D. C.**

BOOKS

CATALOGUE FREE.

For MACHINISTS, ENGINEERS, ELECTRICIANS,

PHILADELPHIA BOOK CO., PRACTICAL AND SCIENTIFIC.

19 S. Ninth St., PHILADELPHIA, PA.

(Continued from page 30.)

great activity can hardly be expected before the opening of spring, at least.

A 26,000-ton purchase of gray forge iron was made last week by the National Foundry & Pipe Works, of Scottdale, to cover their order for cast iron pipe received from Baltimore. One of the Westinghouse interests made a purchase of 10,000 tons of No. 1 foundry iron a few weeks ago, while several other large sales have been reported.

Foundries throughout this section are making more heats, and an air of prosperity seems to be overhanging this branch of trade. No specially large castings have been made lately in any of the plants.

In the machinery line, shops are gradually being put on longer time, with an increased force of men. Shipments have been made, to all parts of the country, of heavy machinery. The Frank-Kneeland Machine Company recently shipped to Russia a large lot of plate mill rolls, tables, charging cranes, etc., for the new steel plant to be erected at Mariopol. The company also shipped what is said to be the largest shear ever built, to a Reading, Pa., concern. The machine weighed 92,000 pounds and will cut 4¼ x 4½-inch cold steel. Other concerns had some conditional orders, work on which is being pushed rapidly. The contracts for the rolling mill equipment for the Buhl Steel Company, at Sharon, Pa., were awarded the Lloyd-Booth Company, of Youngstown, and Mackintosh, Hemphill & Co., of Pittsburg.

Mill supply people have been kept fairly busy on new work. The prices for belting, etc., have been advanced from 5 to 10 per cent., and new price lists have been sent out by many of these manufacturers. The Pittsburg Gage & Supply

Company, Chas. A. Turner & Co. and Speck, Marshall & Co., of this city, have made shipments of a heavy kind within the past few weeks.

Quotations.

NEW YORK, Monday, November 30th.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 50 @ $13 00
No. 2 foundry, Northern	11 50 @ 12 00
No. 2 plain, Northern	11 25 @ 11 50
Gray Forge	11 00 @ 11 50
No. 1 foundry, Southern	12 00 @ 12 50
No. 2 foundry, Southern	11 25 @ 11 75
No. 3 foundry, Southern	10 75 @ 11 25
No. 1 soft, Southern	11 50 @ 12 00
No. 2 soft, Southern	11 00 @ 11 50
Foundry forge, or No. 4 Southern	10 50 @ 11 00

Bar Iron—Base—Mill price, in carloads, on dock; common, 1.15 @ 1.20c.; refined, 1.25 @ 1.50c. Store prices: common, 1.40 @ 1.50c.; refined, 1.50 @ 1.80c.

Tool Steel—Ordinary sizes, standard quality, 6 @ 7c., with some brands perhaps a little less; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—Ordinary brands, from store, 1.70 @ 1.80c.

Cold Rolled Steel Shafting—Base size in carloads, about 2½c.; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 11⅝ @ 11¾; electrolytic, 11¼ @ 11⅜c.; casting copper, 11⅛ @ 11¼c.

Pig Tin—For 5 and 10-ton lots, 13.00 @ 13.10c., f.o.b.

Pig Lead—In carload lots, 3.05 @ 3. 0c., f. o. b.

Spelter—In carload lots, New York delivery, 4.25c., f. o. b.

Antimony—Cookson's, 7¼ @ 7½c.; Hallett's, 6½ @ 6⅝c.; Japanese, 6⅛ @ 6⅜c.

Lard Oil—Prime city, present make, commercial quality, in carload lots, 42 @ 44c.

▲ ▲ ▲

Manufactures.

At Bristol, R. I., a new rubber factory is being erected.

A new mill is to be erected at Cooper Hill, Cheyenne, Wyoming.

Mr. H. H. Hunt, Ald, Mass., intends placing a new engine in his mill.

D. Kidder & Son are erecting a machine shop at North Groton, N. H.

E. D. Shaw & Co. are building an iron foundry at North Plymouth, Mass.

F. Randol & Son, will soon start a bicycle factory at Janesville, Wis.

The erection of an electric light plant is contemplated at Dunmore, Pa.

The Forsythe-Blair Foundry, Trinidad, Col., intend to add some new machinery.

Ansonia Electrical Company, Ansonia, Conn., are making an addition to their shop.

McClave & Brooks, North Sumner Avenue, Scranton, Pa., are to erect a new foundry.

The Yorktown, Ind. glass factory recently destroyed by fire, is to be replaced by a new one.

The Baltimore & Ohio Railroad Company intend to erect car repair shops at Keyser, W. Va.

The Hamilton Machine and Foundry Co., Hamilton, O., intend making an addition to their plant.

The Campbell & Zell Company, Baltimore, Md., went into the hands of receivers, on the 25th inst.

J. W. Place & Co., Bayonne, N. J., contemplate the erection of a large silk mill at Philadelphia, Pa.

Columbia Rolling Mill Company, Columbia, Pa., expect to install improved machinery in their mill.

Mann Bros., E. Brookfield, Mass. have leased the Sagendorph Mill, and will install new machinery.

The Cummer Lumber Company of Codillac, Mich., intend to erect a new saw mill at Jacksonville, Fla.

A new set of foundry buildings for the Walker & Pratt Company is being erected at Watertown, Mass.

Messrs. Z. W. Hood & Son, Athens, Ga., will soon open a foundry and machine works at Harmony Grove.

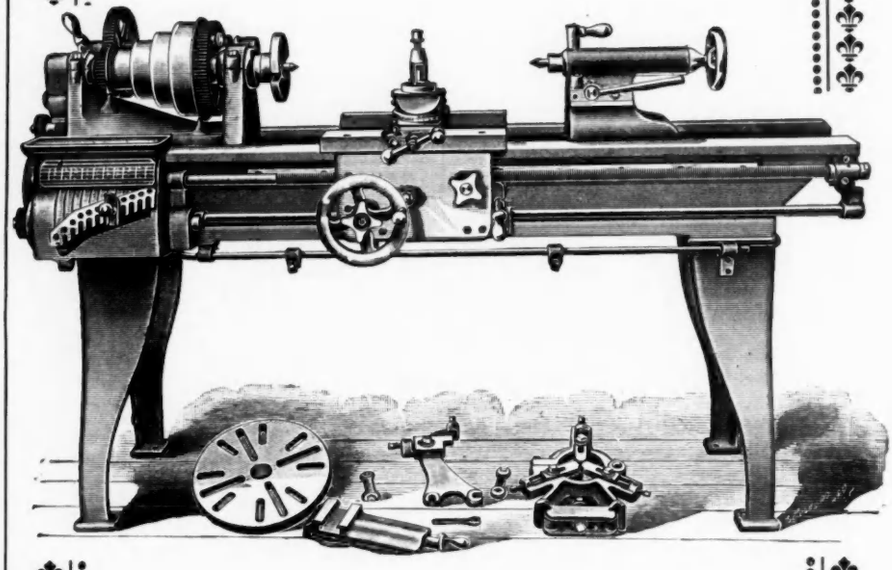
Fels & Co., Philadelphia, Pa., will make an addition to their soap factory, 75 x 73 feet and three stories high.

Messrs. Ed. Foglesanger and Wm. Snoke will

(Continued on page 39.)

H M CO H M CO H M CO H M CO

This lathe combines the latest and best improvements.



14″ x 6′ Hendey-Norton Lathe

With Improved Automatic Stop.

Automatic Stop

It is durable, simple, indispensable. It will automatically stop the carriage in either direction. It is equally efficient whether feeding or thread-cutting, running up to a shoulder, boring to bottom of holes, or internal thread-cutting. No danger of spoiling either tool or work. It is a safeguard against accidents in either direction.

Carriage

The carriage reverses in apron; no slamming of countershaft. There is no comparison between this lathe and the old style or common lathe.

Threads

It has all threads in daily use with simple movement of lever.

Feeds

Has all feeds in daily use with simple movement of lever. Send for Circular.

The Hendey Machine Co.,

Torrington, Conn.

Agents for the Pacific Coast, Pacific Tool & Supply Co., San Francisco, Cal.

European Agents, Chas. Churchill & Co., London and Birmingham. Schuchardt & Schütte, Berlin and Vienna. Eugene Soller, Basel, Switzerland.

H M CO H M CO H M CO H M CO

The Pratt & Whitney Co. HARTFORD, CONN., U.S.A.

...MAKERS OF...

Fine Machine Tools.

Complete Plants furnished for Bicycle, Typewriter, Gun and Sewing Machine Makers. Gauges and Small Tools for all Machine Work. Drop Hammers and Trimming Presses. Forging and Trimming Dies for all classes of work.

England—Buck & Hickman, 280 Whitechapel rd., London, E.; Chas. Churchill & Co., Ltd., London and Birmingham. *France*—F. G. Kreutzberger; Fenwick Freres & Co., 21 Rue Martel, Paris.
Chicago—42 and 44 S. Clinton st. *Boston*—281 Franklin st. *New York*—123 Liberty st.

Genuine Lightning Screw Plates,

Taps, Dies, Reamers, Green River Screw Plates, Bolt Cutters, Drilling Machines, etc.

SEND FOR CATALOGUE.

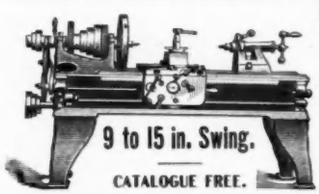
WILEY & RUSSELL MFG. CO.,
GREENFIELD, MASS., U. S. A.

SUITABLE FOR A CHRISTMAS PRESENT.

Kent's Mechanical Engineers' Pocket Book.

12MO, MOROCCO, $5.00.

JOHN WILEY & SONS, 53 East 10th Street, New York City.



CATALOGUE FREE.

SPEAKING OF LATHES! We are building them in various sizes from 9-in. to 15-in. swing, in various lengths, both engine and speed lathes. Our designs are the latest and most approved, while the workmanship, material and finish are of the highest order. Our catalogue will tell you all about them, as well as of our planers, shapers, drills and other tools and supplies.

SEBASTIAN LATHE COMPANY,
117 and 119 CULVERT STREET, CINCINNATI, OHIO.

DYER & DRISCOLL,
PATENT SOLICITORS, 36 WALL ST., N.Y.

Have done all my patent soliciting work, both for this and foreign countries, continously for the past fourteen years.

Thomas A. Edison

STAR LATHES

★★★

Foot Power Screw Cutting, Automatic Cross Feed, 9 and 12" Swing.

Send for Catalog B.

Seneca Falls Mfg. Co.
687 Water St., Seneca Falls, N.Y.

WHEN YOU ARE OFFERED JENKINS' or JENKINS BROS.' DISCS

that have Trade Mark same as cut, they are all right for high pressure steam. All others are imitations and you cannot hold us responsible. If you cannot get our discs from your dealer, send to us for them.

JENKINS BROS., 71 John Street, New York.
31 N. Canal St., Chicago. 117 N. 4th St., Philadelphia. 105 Milk St., Boston.

Walker Universal Tool and Cutter Grinder.

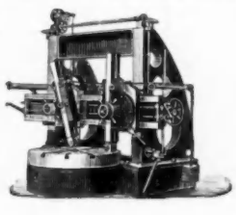
SEND FOR COMPLETE CATALOGUE.

NORTON EMERY WHEEL CO.
WORCESTER, MASS.

MODERN MACHINE TOOLS

Constructed from designs embodying all the late improvements in economy, manipulation, strength and accuracy.

BETTS MACHINE CO., Wilmington, Del., U.S.A.



(Continued from page 38.)

erect in the near future a large planing mill in Shippensburg, Pa.

At Gold Hill, Col., a chlorination plant will be erected by the Carbon County and Gold Coin mining companies.

Messrs. Brandan & Son have made an addition to their mill at Clarksville, Fla., and will soon place new machinery.

The Cleveland-Lorain Electric Railroad intend to build a power house on the George Smith farm, near Lorain, O.

Oakland City, Ind., is to put in a water works system. Boilers, pumps, etc., will be installed. G. H. Gregory & Son, Oakland City, are interested.

Joseph S. McKiel, Chillicothe, Ohio, and a number of others, contemplate the operation of a beet sugar factory. An old distillery will be fitted up for the purpose.

The Riverside Mills Company, Providence, R. I., has given orders for the erection of an additional building, to be three stories in height, the dimensions to be 100x50 feet.

A new woolen yarn factory will be built on Market Street, Camden, N. J., for Messrs. Shiner & Boyer, Philadelphia, Pa.

A new company under the name of the Crucible Steel Co. has been organized in Canton, O. Messrs. J. C. Welty, S. P. Albaugh, A. R. Graham, Charles Graham, etc., are interested.

S. A. Reed will build a brick boiler-house in rear of 416 Sixth street north-west, Washington, D. C., and make general interior repairs.

The American Leather Company of Wilmington, Del., has rented the large factory at Fourth and Monroe streets, and will enlarge the plant.

The Kimberly & Clark Company, Appleton, Wis., will soon begin the construction of an envelope factory which will be equipped with new machines.

The New Orleans Traction Company, New Orleans, La., contemplates making extensive additions to its power plant. Mr. C. D. Wyman is general manager.

A large addition is being built on the factory of Marron Bros., on Monk street, Houghton, Mass. They are also adding a new 75 horse-power boiler to the plant.

The Calumet & Hecla Mining Company have decided to erect an eleven-head stamp mill at Lake Linden, Marquette, Mich. Mr. Agassiz is president of the company.

The Grosvenor Dale Company of Putnam, Conn., is pushing its new mill to completion. The building will cost about $1,000,000 and will be equipped with 75,000 spindles.

Berlin Iron Bridge Company, E. Berlin, Conn., have secured the contract for steel roofs of the new power station of the Stamford Gas and Electric Company at Stamford, Conn.

The Curtis & Marble Machine Company is building a new machine shop at Worcester, Mass. This new building will be 64 x 228 ft., and all improved machinery will be installed.

G. B. Williscraft, proprietor of the Phoenix Iron Works, Phoenix, Arizona, is planning to build an extensive addition to his foundry on South Seventh avenue. It will be used as a machine shop.

The works of the Structural Iron and Steel Company, Columbus, Ohio, will be enlarged. Hon. Mike Stanton, Adam Busch, J. W. Bannon and B. F. Vincent are interested in this enterprise.

Ground has been broken for an addition to the Goodyear Metallic Rubber Shoe company's plant, Naugatuck, Conn. It is to be of brick, 30x40 feet, and will be completed as rapidly as possible.

The Schwarzschild & Sulzberger Packing Company, Armourdale, Mo., will build a $30,000 glue works. It will be three stories high, and built of brick and the latest machinery will be installed.

N. L. Millard & Co., North Adams, Mass., are planning to enlarge their capacity for manufacturing shoes by building an addition to their factory. The new building will be of wood, three stories high.

Bickford's Full Universal Radial Drill.

THAT'S THE MACHINE SHOWN HEREWITH.

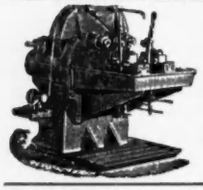
Do you know that

- This Drill is positively full universal: Both head and arm rotating completely.
- No adjusting or moving of heavy castings at all: Only one setting and the drill gets at every hole.
- Double columns used; No break-downs ever known.
- Roller bearings for quick movements.
- Rack Feed to spindle, with quick return movement.
- PROMPT DELIVERIES GUARANTEED.
- Our new shop just finished: Thirty thousand square feet floor space for building our line of drills.
- Catalogue tells the rest: Better have a copy sent you.
- Everything else desired in Drilling Machinery is made by us.

Bickford Drill and Tool Co.,
3 Pike Street, CINCINNATI, Ohio, U. S. A.

THIS **BRUSH**

Don't look like anything you ever saw before!
ELEGANT and USEFUL.....
A Modern Article. Low in Price. High in Quality.
FOR CASTINGS.
...
THE BUCHEL MACHINE WORKS,
NEW ORLEANS, LA.
Send for Circular. Mention "Machinist."



Automatic Solid Die Bolt
THREADING MACHINES.
Two Styles. Four Sizes
Send for Catalogue "A."
WEBSTER & PERKS TOOL CO
Cor. Spring and Monroe Sts.,
Springfield, Ohio

The best Bicycle Brazing Solder is the Ball's Wire Spelter made by Montgomery of N. Y. It is not the cheapest. The best Bicycle wheels will use it. Get samples, make up your mind and place your orders early.
Montgomery & Co.
105 Fulton St.
New York City.

ARE YOU PUNCHING ANYTHING?

In two operations that you would like to do in one? If so, send us a sketch, or, better still, a sample, and see what we can do. Never mind if your boss press hand says it can't be done. Give us a try. We don't profess to know it all, but we do profess to know something about Compound Dies, and what we can do with them—and don't forget our new address,

MOSSBERG & GRANVILLE MFG. CO.
101 Sabin Street, Providence, R. I.

EMERY AND CORUNDUM WHEELS,

The kind that cut and wear. Specially adapted for reamer cutter, gear, drill and all machine tool grinding, wet or dry. "IRON AGE" and wire web wheels for snagging and rough work. Send for Circular "E."

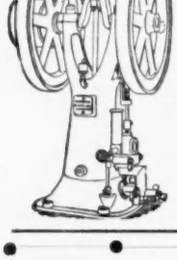
VITRIFIED WHEEL COMPANY,
WESTFIELD, MASS.
London Agents, CHARLES NEAT & CO.

POWER PRESSES

Punches and Shears,
...

REDUCING, FORMING AND FLARING ROLLS.
...
Power Hammers and Forging Machines.
...
DIES AND SPECIAL MACHINERY.
...
GODFREY J. BREMER MACHINE CO.
KALAMAZOO, MICH., U. S. A.
Write for Catalogue "A" and Price List.

WRIGLEY'S EMERY WHEEL DRESSER
PAT JUNE 17 1890
SENT ON TRIAL
To be returned or paid for in 30 days. It faces rapidly or cuts V-grooves and all Shapes. Cutters are Self-Sharpening; has hardened steel-faced Side Bearings and hardened steel-bushed Pin Bearings. Price, $2.00; Cutters, 25 cts. per set. Send for Circular. Discount to the Trade.
T. WRIGLEY, 85-87 Fifth Ave., Chicago, U.S.A.
Chas. Churchill & Co., ltd., London, Ag'ts for Great Britain.



This Beats Wind, Steam or Horse Power.
We offer the
WEBSTER 2 1-2 ACTUAL HORSEPOWER
GAS ENGINE
For $150, less 10 per cent. discount for cash. Built on the interchangeable plan. Built of the best material. Made in lots of 100, therefore, we can make the price. Boxed for shipment, weight 800 pounds. Made for Gas or Gasoline.
Write for Special Catalog.
WEBSTER MFG. CO.
1079 W. 15th St., CHICAGO.

Columbia University
in the City of New York.

SCHOOL OF MINES,
SCHOOL OF CHEMISTRY,
SCHOOL OF ENGINEERING,
SCHOOL OF ARCHITECTURE,
SCHOOL OF PURE SCIENCE.

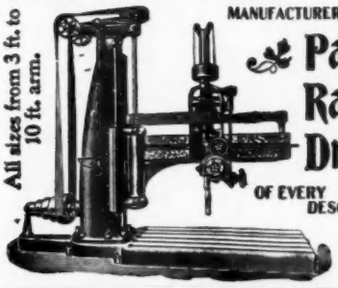
Four years' undergraduate courses and special facilities for graduate work in all departments. Circulars forwarded on application to the Secretary of the University.

Engine Lathes
14 to 30 inches.

DIETZ, SCHUMACHER & BOYE,
70, 72, 74, 76 Plum Street,
313, 315, 317 West Second Street,
CINCINNATI, OHIO, U. S. A.

BAUSH & HARRIS MACHINE TOOL CO. HOLYOKE, MASS.

MANUFACTURERS OF



All sizes from 3 ft. to 10 ft. arm.

Patent Radial Drills

OF EVERY DESCRIPTION.

CUTTING OFF MACHINES, the Latest and Best.

HURLBUT ROGERS MACHINE CO.,

SO. SUDBURY, MASS.

German Agents: Schuchardt & Schutte, Berlin and Vienna.

English Agents: Chas. Churchill & Co., Ltd., London and Birmingham.

Miner & Peck Mfg. Co., New Haven, Conn.

SEND FOR CATALOGUE.

WORCESTER MACHINE SCREW CO

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

THE WATERBURY
FARREL FOUNDRY
AND MACHINE CO.

Waterbury, Conn., U. S. A.

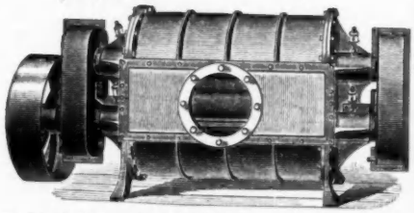
BUILDERS OF MACHINERY FOR MAKING

HARDWARE

STEEL TUBE, BICYCLE PARTS, BRASS GOODS, SILVERWARE AND STEEL GOODS.

Roots' Blowers.

Unsurpassed for any purpose where a blast or suction of air is required. The only Rotary Blower built for high pressures.



P. H. & F. M. ROOTS CO., Manufacturers,
CONNERSVILLE, IND.

NEW YORK OFFICE: 109 Liberty Street.
J. B. STEWART, Manager.

In writing please mention this paper.

BUFFALO VENTILATING FANS

ELECTRIC, STEAM AND PULLEY TYPES. GREATEST AIR VOLUME, LEAST POWER

BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

Chicago, 22 and 24 West Randolph Street.

New York, 26 Cortlandt Street.

PROGRESSIVE AND APARTMENT TYPES

BUFFALO LUMBER DRY KILNS.

BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

H. W. JOHNS'

ASBESTOS SECTIONAL PIPE COVERINGS.

Non-Conducting Coverings for Steam and Hot Water Pipes, Boilers, etc.
ASBESTOS BOILER COVERINGS.
H. W. JOHNS MANUFACTURING COMPANY,
H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.

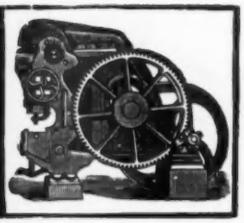
87 MAIDEN LANE, N. Y. Jersey City, Chicago, Philadelphia, Boston, London.

CRANES, TROLLEYS, PORTABLE HOISTS; OVERHEAD TRACK.

SEND FOR CATALOGUE.

MARIS BROS., 2343 & 2345 Callowhill St., PHILADELPHIA, PA.

PUNCHING AND SHEARING MACHINERY
AND BOILER MAKERS ROLLS.
NEW DOTY MANUFACTURING CO.
JANESVILLE WISCONSIN.

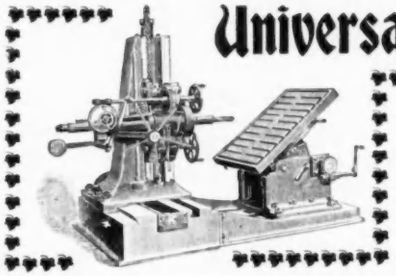


THE Q AND C
GEN'L OFFICES CHICAGO ILL.
NEW YORK 100 B'WAY
BOSTON 70 KILBY

OLD SAWS

AUTOMATIC FEED SHOP SAWS NO. 2 & 4. CATALOGUE
LARGE POWER AND PORTABLE RAIL
ENT FREE.
CORRESPONDENCE OLICITED.

Universal Horizontal Drill.



Five sides of a cube can be drilled at any angle without re-chucking the work.

Write

DETRICK & HARVEY MACHINE CO.,
Baltimore, Md., U. S. A.

The Flather Lathe, 22 inch.

FLATHER & COMPANY,
NASHUA, N. H., U. S. A.

LATHES,
SCREW MACHINES,
PLANERS AND SHAPERS.

BROWN & SHARPE MFG. CO. MACHINERY AND TOOLS.

PROVIDENCE, R. I.

UNIVERSAL GRINDING MACHINES.

No. 1, 8 in. x 16 in.
No. 3, 20 in. x 72 in.
No. 2, { 12 in. x 30 in. / 12 in. x 40 in.

"We find them indispensable in our shop. It has become with us, pretty well understood, that there is no way to make a good journal bearing and other cylindrical surfaces, except by grinding.
THE PRATT & WHITNEY CO."

We are pleased to mail circulars or catalogue (366 pages) upon application.

NEW YORK OFFICE. 136 Liberty St., Room 507.
CHICAGO OFFICE AND STORE, 23 South Canal St.

AGENTS.

BUCK & HICKMAN, 280 Whitechapel Road, London, E.
CHAS. CHURCHILL & CO., Ltd., London and Birmingham.
GUSTAV DIECHMANN & SOHN, Zimmerstrasse 87, Berlin, S. W. 12.
FENWICK FRERES & CO., 21 Rue Martel, Paris
U. BAIRD MACHINERY CO., 74 Water St., Pittsburgh, Pa.
R. HOFFELD & CO., 61 Carroll St., Buffalo, N. Y.
E. A. KINSEY & CO., 227 W. 4th St., Cincinnati, O.
MANNING, MAXWELL & MOORE, 111 Liberty St., New York City.

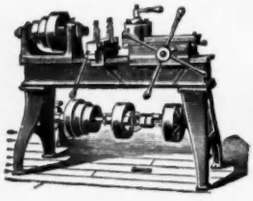
FIFIELD TOOL CO.,

MANUFACTURERS OF

ENGINE LATHES

from 17 to 64 in. swing. Cuts, Photographs and Prices furnished on application.

LOWELL, MASS., U. S. A.



WARNER & SWASEY,

CLEVELAND, OHIO.

MANUFACTURERS OF

MONITOR LATHES

SIX SIZES

IRON AND BRASS WORKING MACHINERY.

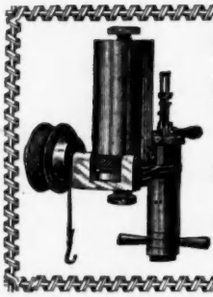
SEND FOR ILLUSTRATED CATALOGUE.

THE HARRINGTON & KING PERFORATING CO.

PERFORATED METALS OF EVERY DESCRIPTION FOR ALL PURPOSES

CHICAGO 227 N. UNION ST.

EASTERN OFFICE NO. 264 PEARL ST. NEW YORK



ASHCROFT MANUFACTURING CO.

MANUFACTURERS OF

The Tabor Steam Engine Indicator.

FITTED WITH HOUGHTALING REDUCING MOTION.

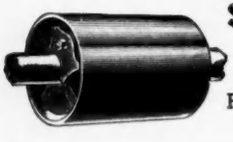
A PERFECT INDICATOR. Recognized as the highest standard in all parts of the world.

Send for our book on the Indicator. Sent free.

OFFICE & SALESROOM: 111 & 113 LIBERTY STREET, NEW YORK.
424 TELEPHONE BUILDING, PITTSBURGH, PA. | 60 SOUTH CANAL ST. CHICAGO, ILL.

Wanted—An Idea

Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write JOHN WEDDERBURN & CO., Patent Attorneys, Washington, D. C., for their $1,800 prize offer and list of two hundred inventions wanted.



Stuart's Patent Compression Wedge Coupling.

REQUIRING NO KEYS.

Have successfully stood the test for 9 years and are still being shipped *on trial, or money returned* if you want it. All sizes kept in stock.

R. J. STUART'S FOUNDRY AND MACHINE WORKS,
NEW HAMBURGH, N. Y.

Fine Grade Drop Forgings.

WYMAN & GORDON,

WORCESTER, MASS.

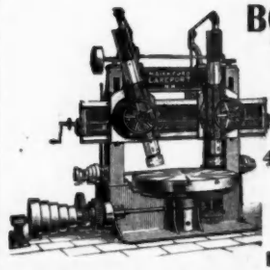
THE TRENTON IRON CO.,

Manufacturers of Iron and Steel

WIRE AND WIRE ROPE.

Patent Wire Rope Tramways.
Cableways and Quarry Hoists.
Best Grades of Steel Wire, tempered and untempered.
Cast Steel Music Wire.
Iron and Steel Wire up to ¾-in. diameter, straightened and cut to lengths.

WORKS AND OFFICE, TRENTON, N.J. ⚜ COOPER HEWITT & CO., NEW YORK. ⚜ 1114 MONADNOCK BUILDING, CHICAGO.



BORING AND TURNING MILLS,

4, 5 & 6 ft. Swing

H. BICKFORD,

LAKEPORT, N. H.

JONES & LAMSON MACHINE COMPANY, SPRINGFIELD, VT.

SEE PAGE 14.

FLAT TURRET LATHE.